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Department of Defense FY 1999 President's Budget

February 1998

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RESEARCH, DEVELOPMENT, TEST AND EVALUATION, DEFENSE-WIDE

Volume 1 - Defense Advanced Research Projects Agency

UNCLASSIFIED

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY
RESEARCH, DEVELOPMENT, TEST AND EVALUATION, DEFENSEWIDE
PE/PROJECT LEVEL SUMMARY REPORT
($ in millions)

PE	PROJ	TITLE	FY 1997	FY 1998	FY 1999
61101E					
	CCS-02	INFORMATION SCIENCES	28.652	16.817	18.900
	ES-01	ELECTRONIC SCIENCES	49.275	37.210	28.511
	MS-01	MATERIALS SCIENCES	11.438	14.305	17.691
61101E		DEFENSE RESEARCH SCIENCES	89.365	68.332	65.102
62110E	NGI-01	NEXT GENERATION INTERNET	0.000	40.453	40.000
62301E					
	ST-01	JASONS	1.169	1.291	1.200
	ST-11	INTELLIGENT SYSTEMS & SOFTWARE	86.349	91.981	81.700
	ST-19	HIGH PERFORMANCE AND GLOBAL SCALE SYSTEMS	166.059	157.784	193.314
	ST-22	SOFTWARE ENGINEERING TECHNOLOGY	15.994	16.609	17.100
	ST-24	INFORMATION SURVIVABILITY	35.195	41.372	54.509
	ST-25	ADAPTIVE COMPUTING	0.000	0.000	0.000
	ST-26	JOINT INFRASTRUCTURE PROTEC	0.000	0.000	69.900
62301E		COMPUTING SYS & COMM TECHNOLOGY	304.766	309.037	417.723
62383E	BW-01	BIOLOGICAL WARFARE DEFENSE	0.000	60.805	88.000
62702E					
	TT-03	NAVAL WARFARE TECHNOLOGY	31.579	20.783	16.796
	TT-04	ADVANCED LAND SYSTEMS TECHNOLOGY	22.470	20.817	35.000
	TT-06	ADVANCED TACTICAL TECHNOLOGY	36.447	55.091	71.534
	TT-07	AERONAUTICS TECHNOLOGY	14.694	20.235	34.000
	TT-10	ADVANCED LOGISTICS TECHNOLOGY	18.333	21.214	21.665

Exhibit R-1

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY
RESEARCH, DEVELOPMENT, TEST AND EVALUATION, DEFENSEWIDE
PE/PROJECT LEVEL SUMMARY REPORT
($ In millions)

PE	PROJ	TITLE	FY 1997	FY 1998	FY 1999
	TT-11	JOINT LOGISTICS ACTD	0.000	10.191	10.000
62702E		TACTICAL TECHNOLOGY	123.523	148.331	188.995
62708E	IC-03	INTERGRATED COMMAND & CONTROL TECH	58.824	45.695	34.000
62712E	MPT-01	MATERIALS PROCESSING TECHNOLOGY	110.200	122.081	145.381
	MPT-02	MICROELECTRONIC DEVICE TECHNOLOGIES	56.530	74.520	87.910
	MPT-06	CRYOGENIC ELECTRONICS	16.650	18.404	8.203
	MPT-07	MILITARY MEDICAL/TRAUMA CARE TECHNOLOGY	20.507	16.348	2.914
62712E		MATERIALS & ELECTRONICS TECHNOLOGY	203.887	231.353	244.408

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY
RESEARCH, DEVELOPMENT, TEST AND EVALUATION, DEFENSEWIDE
PE/PROJECT LEVEL SUMMARY REPORT
($ in millions)

PE	PROJ	TITLE	FY 1997	FY 1998	FY 1999
63739E					
	MT-03	UNCOOLED INTEGRATED SENSORS	18.912	8.669	11.000
	MT-04	ELECTRONIC MODULE TECHNOLOGY	53.510	68.268	65.992
	MT-05	TACTICAL INFORMATION SYSTEMS	23.951	29.472	36.496
	MT-06	MICROWAVE & ANALOG FRONT END TECHNOLOGY	38.015	18.250	4.000
	MT-07	CENTERS OF EXCELLENCE	20.449	3.852	4.000
	MT-08	MANUFACTURING TECHNOLOGY APPLICATIONS	31.447	29.162	25.200
	MT-10	ADVANCED LITHOGRAPHY	60.827	51.078	26.500
	MT-11	ELECTRONIC COMMERCE RESOURCE CENTERS	34.288	0.000	0.000
	MT-12	MEMS	60.844	73.158	71.549
	MT-13	ADVANCED MICROSYSTEMS	0.000	0.000	0.000
63739E		ADVANCED ELECTRONICS TECHNOLOGY	342.243	281.909	244.737
63746E	MR-01	MARITIME TECHNOLOGY	47.347	36.030	15.000
63747E	EV-01	ELECTRIC VEHICLES	14.693	14.522	0.000
63760E					
	CCC-01	COMMAND & CONTROL INFORMATION SYSTEMS	43.489	64.125	81.200
	CCC-02	INFORMATION INTEGRATION SYSTEMS	55.351	85.885	118.900
63760E		COMMAND, CONT'L & COMMUNICATION SYS	98.840	150.010	200.100
63761E					
	CST-01	ADVANCED SIMULATION	40.507	30.142	26.698
	CST-02	GLOBAL GRID COMMUNICATIONS	50.995	41.302	27.916
	CST-03	DEFENSE SIMULATION INTERNET	33.459	2.768	1.500
63761E		COMMUNICATION & SIMULATION TECH	124.961	74.212	56.114

Exhibit R-1

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY
RESEARCH, DEVELOPMENT, TEST AND EVALUATION, DEFENSEWIDE
PE/PROJECT LEVEL SUMMARY REPORT
($ In millions)

PE	PROJ	TITLE	FY 1997	FY 1998	FY 1999
63762E					
	SGT-01	GUIDANCE TECHNOLOGY	12.974	36.668	36.872
	SGT-02	AEROSPACE SURVEILLANCE TECHNOLOGY	1.471	19.603	70.500
	SGT-03	AIR DEFENSE INITIATIVE	18.854	20.906	33.050
	SGT-04	SENSORS & EXPLOITATION SYSTEMS	71.000	90.007	72.732
63762E		SENSOR & GUIDANCE TECHNOLOGY	104.299	167.184	213.154
63763E					
	MRN-01	ARSENAL SHIP	19.366	0.000	0.000
	MRN-02	ADVANCED SHIP/SENSOR SYSTEM	21.819	19.626	24.788
63763E		MARINE TECHNOLOGY	41.185	19.626	24.788
63764E					
	LNW-01	RAPID STRIKE FORCE TECHNOLOGY	19.211	42.315	52.600
	LNW-02	SMALL UNIT OPERATIONS	43.170	38.609	55.890
63764E		LAND WARFARE TECHNOLOGY	62.381	80.924	108.490
63765E	CLP-01	CLASSIFIED DARPA PROGRAMS	172.895	129.411	55.500
63800E	JA-01	JOINT STRIKE FIGHTER PROGRAM	70.261	23.019	0.000
63805E					
	GC-01	DUAL USE APPLICATIONS PROGRAMS	73.678	120.395	0.000
	GC-02	DUAL USE APPLICATIONS PROGRAMS - ONE YEAR	49.490	0.000	0.000
63805E		DUAL USE APPLICATIONS PROGRAM	123.168	120.395	0.000

Exhibit R-1

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY
RESEARCH, DEVELOPMENT, TEST AND EVALUATION, DEFENSEWIDE
PE/PROJECT LEVEL SUMMARY REPORT
($ In millions)

PE	PROJ	TITLE	FY 1997	FY 1998	FY 1999
65114E	BL-01	BLACKLITE	4.518	4.532	5.000
65502E	SB-01	SMALL BUSINESS INNOVATIVE RESEARCH	45.660	0.000	0.000
65898E	MH-01	MANAGEMENT HEADQUARTERS	35.340	35.039	38.611
99900E	EA-01	EXPIRED ACCOUNT ADJUSTMENTS	1.815	0.000	0.000
		AGENCY TOTAL	2,069.971	2,040.819	2,039.722

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY
RESEARCH, DEVELOPMENT, TEST AND EVALUATION, DEFENSEWIDE
PE/PROJECT LEVEL SUMMARY REPORT
($ in millions)

PE	PROJ	TITLE	FY 1997	FY 1998	FY 1999
	BA-01	TOTAL	89.365	68.332	65.102
	BA-02	TOTAL	691.000	835.674	1,013.126
	BA-03	TOTAL	1,202.273	1,097.242	917.883
	BA-06	TOTAL	87.333	39.571	43.611
	AGENCY TOTAL		2,069.971	2,040.819	2,039.722

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

DATE February 1998

| APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 1 Basic Research | | | | R-1 ITEM NOMENCLATURE Defense Research Sciences, PE 0601101E, R-1 #2 | | | | |

COST (*In Thousands*)	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Defense Research Sciences	**89,365**	**68,332**	**65,102**	**65,400**	**70,036**	**71,186**	**76,936**	**Continuing**	**Continuing**
Information Sciences CCS-02	28,652	16,817	18,900	20,100	19,500	19,700	19,700	Continuing	Continuing
Electronic Sciences ES-01	49,275	37,210	28,511	25,678	30,583	30,433	36,183	Continuing	Continuing
Materials Sciences MS-01	11,438	14,305	17,691	19,622	19,953	21,053	21,053	Continuing	Continuing

(U) **Mission Description:** The Defense Research Sciences Program element is budgeted in the Basic Research Budget Activity because it provides the technical foundation for long-term improvements through the discovery of new phenomena and the exploration of the potential of such phenomena for national security applications. It supports the scientific study and experimentation that is the basis for more advanced knowledge and understanding in information, electronic and materials sciences.

(U) The Information Sciences project supports basic scientific study and experimentation in software technology, intelligent systems technology, human-language systems, and varied aspects of high performance computing.

(U) The Electronic Sciences project explores and demonstrates electronic and optoelectronic devices, circuits, and processing concepts that will provide: (1) new technical options for meeting the information gathering, transmission and processing required to maintain near-real time knowledge of the enemy, and the ability to communicate decisions based on that knowledge to all forces in near-real time; and (2) a substantial increase in performance and cost reduction of military systems providing these capabilities.

(U) The Materials Sciences project is concerned with the development of: high power density/high energy density mobile and portable power sources; magneto-resistive materials for use in radiation hardened memories and motion sensors; processing and design approaches for nanoscale and/or biomolecular materials and interfaces; medical pathogen countermeasures; and advanced thermoelectric materials for cooling and power generation.

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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

| | DATE | February 1998 |

| APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 1 Basic Research | R-1 ITEM NOMENCLATURE
Defense Research Sciences,
PE 0601101E |

COST *(In Thousands)*	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Information Sciences CCS-02	28,652	16,817	18,900	20,100	19,500	19,700	19,700	Continuing	Continuing

(U) **Mission Description:** This project supports the scientific study and experimentation that is the basis for more advanced knowledge and understanding in information sciences technology areas related to long-term national security requirements, such as: computational models, organizing intelligent systems, human computer interface and microelectronic science.

(U) In the area of computational models, the project will identify and probe new classes of computing technologies which may offer spectacular performance/cost/size/weight/power improvements beyond the ultimate limitations of today's semiconductor-based computing. The intelligent systems technology focus is on advanced techniques for knowledge representation, reasoning, and machine learning, which enables computer understanding of spoken and written language and images. Also included are advanced methods for planning, scheduling, and resource allocation. The focus in the human computer interaction technology area is design methods and enabling technology for more natural interaction between people and computers. Lastly, the microelectronic science focus is on the circuitry and software to enable highly configurable computational and storage elements.

(U) **Program Accomplishments and Plans:**

(U) FY 1997 Accomplishments:

- Completed the development of tool kits for the evaluation of highly interactive, agent and dialogue-based human computer interactions. ($4.7M)
- Advanced the capabilities of spoken and written language understanding to solve real-world problems; feasibility demonstrations at USACOM and integration with JTF ACTD. ($5.5M)
- Evaluated design technology for high performance prototyping of computational systems. ($2.2M)
- Experimentally supported software evolution by: prototyping tools for discovery/reengineering of user interface functionality; enhancing formal notations for software engineering to express assumptions made by designers; and demonstrating groupware tools to capture design rationale. ($5.1M)

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

DATE February 1998

| APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 1 Basic Research | R-1 ITEM NOMENCLATURE
Defense Research Sciences,
PE 0601101E, Project CCS-02 |

- Continued the experimental evaluation of supporting both task and data parallelism for scalable software library technology. ($1.2M)
- Developed the theoretical basis for using ULTRASCALE computing techniques to perform encryption/decryption. ($2.1M)
- Defined Quorum architecture and defined and validated the next generation of languages and runtime services for supporting parallel task applications. ($1.9M)
- Congressionally directed program for Discovery Center of S&T. ($3.9M)
- Executed the Technology Transfer Pilot Program. ($2.0M)

(U) FY 1998 Program:

- Investigate computational models suitable for implementation using ULTRASCALE computing techniques. ($5.7M)
- Prototype robust spoken and text language technologies with emphasis on affordable dialog grammars and understanding. ($7.9M)
- Develop architecture for low-power configurable computational elements. ($1.3M)
- Evaluate quality of service specifications relative to the Quorum architecture; demonstrate real-time adaptive control and resource management; release version of defense-critical software based on scalable library technology. ($1.9M)

(U) FY 1999 Program:

- Demonstrate and validate ULTRASCALE computing models, with emphasis on: DNA-based logic operations; cell-based computation and novel communication pathways; and the scalability of these techniques in defense applications. ($12.2M)
- Investigate novel control mechanisms for self-organizing and autonomous systems. ($2.0M)
- Demonstrate human-computer dialog interaction for crisis planning and automatic transcription of conversational speech over battlefield radio. ($3.0M)
- Validate low-power configurable architecture; develop supporting software; and demonstrate automated mapping of 500K elements. ($1.7M)

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

DATE	February 1998

APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 1 Basic Research

R-1 ITEM NOMENCLATURE
Defense Research Sciences,
PE 0601101E, Project CCS-02

(U) <u>**Program Change Summary:**</u> *(In Millions)*

	FY 1997	FY 1998	FY 1999
President's Budget	23.5	19.0	18.9
Appropriated	28.4	16.8	N/A
Current Budget	28.6	16.8	18.9

(U) <u>**Change Summary Explanation:**</u>

FY 1997 Increase reflects minor program repricing.

(U) <u>**Other Program Funding Summary Cost:**</u> N/A

(U) <u>**Schedule Profile:**</u> N/A

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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

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| APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 1 Basic Research | R-1 ITEM NOMENCLATURE
Defense Research Sciences,
PE 0601101E |

COST *(In Thousands)*	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Electronic Sciences ES-01	49,275	37,210	28,511	25,678	30,583	30,433	36,183	Continuing	Continuing

(U) **Mission Description:** This project seeks to continue the phenomenal progress in microelectronics innovation that has characterized the last decades by exploring and demonstrating electronic and optoelectronic devices, circuits and processing concepts that will: 1) provide new technical options for meeting the information gathering, transmission and processing required to maintain near real-time knowledge of the enemy, and the ability to communicate decisions based on that knowledge to all forces in near real-time; and 2) provide new means for achieving substantial increases in performance and cost reduction of military systems providing these capabilities. Research areas include new electronic and optoelectronic device and circuit concepts, operation of devices at higher frequency and lower power, extension of diode laser operation to new wavelength ranges relevant to military missions, development of uncooled and novel infrared detector materials for night vision and other sensor applications, development of innovative optical and electronic technologies for interconnecting modules in high performance systems, research to realize field portable electronics with reduced power requirements, and research addressing affordability and reliability.

(U) **Program Accomplishments and Plans:**

(U) FY 1997 Accomplishments:

- Continued the ultra-electronics program with emphasis on the following thrusts: combined nanoelectronics and conventional electronics, silicon-based nanoelectronics, chemical self-assembly, and molecular beam epitaxy (MBE) process control and other fabrication techniques. ($10.8M)
- Fabricated small (5 x 5) infrared sensitive arrays as verification of material properties. ($3.2M)
- Developed and demonstrated UV pulsed laser diode operation in the gallium nitride system. Identified relationship between defect density and applicability to military applications such as UV solar blind detectors for missile threat warning. ($7.2M)
- Continued low-power electronics program in the areas of circuit architecture and power management techniques. Demonstrated 256 X 256 pixel sensor with on-chip 10-bit Analog to Digital Converter (ADC). Demonstrated strategies for non-disruptive power supply switching for reduced power consumption. ($5.8M)
- Explored Ultra Photonics efforts leading to advances in the state-of-the-art of Photonic Device Technologies which became the basis for next-generation optoelectronic devices. ($7.3M)

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 1998
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 1 Basic Research	R-1 ITEM NOMENCLATURE Defense Research Sciences, PE 0601101E, Project ES-01

- Established multi-investigator based centers for research focused on the application of optoelectronic technologies that will enhance the performance of future generations of information processing systems. ($14.9M)

(U) **FY 1998 Program:**

- Optoelectronics - Demonstrate feasibility of using Gallium Nitride detectors as a UV solar-blind detector for missile threat warning and demonstrate UV/blue lasers operating continuous wave for high density memory and chemical/biological detection. ($9.5M)

- Infrared Detector Materials - Determine process for low temperature deposition of thin film uncooled materials. ($2.7M)

- Ultra-Electronics - Demonstrate feasibility of combining a resonant tunneling device (RTD) with conventional devices, silicon based quantum metal oxide semiconductor (MOS) technology, and simple quantum cellular automatic logic circuits using silicon and silicon germanium structures. ($10.3M)

- Ultra-Photonics- Demonstrate practical means for implementing high speed optical buffer memories and signal address recognition based on coherent all-optical (photon-echo) technology. Demonstrate the utility of low cost silicon electronic devices doped with optically active elements (such as Erbium) for applications that are now the exclusive domain of more expensive compound semiconductor devices or glassy materials. ($9.2M)

- Low Power Electronics - Complete low-power electronics programs in the areas of circuit architecture and power management techniques. Demonstrate 256 x 256 pixel image sensor with on-chip 10-bit Analog-Digital Converter. ($5.5M)

(U) **FY 1999 Program:**

- Infrared Detector Materials - Establish feasibility of new uncooled detector structures, including micromachined arrays, thin film ferroelectrics and bolometric materials. ($3.0M)

- Ultra Electronics - Demonstrate programmable matched filter operating at gigahertz speed with substantially less power than silicon complimentary metal oxide semiconductor (Si CMOS), completely integrated molecular beam epitaxy (MBE) growth system which realizes closed-loop control of atomic layer growth and quantum device structures. ($4.9M)

- Ultra-Photonics - Identify the device properties limiting performance of vertical cavity lasers and demonstrate methods for controlling their output beam quality. ($7.7M)

- Integrate promising new elements of ultra-electronics, high power electronics, non-volatile memory and Electro-Magnetic Interference (EMI) electronics. Address, evaluate, and apply current EMI thrusts in smaller, lighter, more mobile information systems and highest performance components and systems. ($9.7M)

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

DATE	February 1998

APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 1 Basic Research	Defense Research Sciences, PE 0601101E, Project ES-01

- Initiate mechanical electronics development resulting in very high efficiency DC-DC converters. ($1.0M)
- Explore technologies for a region of the electromagnetic spectrum (300 Ghz to 10 Thz, 1mm to 30 micrometer) which has previously been difficult to access using conventional technologies, in order to exploit opportunities in environmental sensing, upper-atmosphere imagery, and covert satellite communications. ($2.2M)

(U) **Program Change Summary:** *(In Millions)*

	FY 1997	FY 1998	FY 1999
President's Budget	51.1	42.0	44.3
Appropriated	47.8	37.2	N/A
Current Budget	49.3	37.2	28.5

(U) **Change Summary Explanation:**

FY 1997 Increase reflects rephasing of the Ultra Photonics program.
FY 1999 Decrease reflects completion of the 6.1 portions of the Gallium Nitride and Low Power Electronics programs.

(U) **Other Program Funding Summary Cost:**   N/A

(U) **Schedule Profile:**   N/A

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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

DATE February 1998

APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 1 Basic Research

R-1 ITEM NOMENCLATURE
Defense Research Sciences,
PE 0601101E

COST *(In Thousands)*	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Materials Sciences MS-01	11,438	14,305	17,691	19,622	19,953	21,053	21,053	Continuing	Continuing

(U) **Mission Description:** This project is concerned with the development of: high power density/high energy density mobile and portable power sources; magneto-resistive materials for use in radiation hardened memories and motion sensors; advanced thermoelectric materials for cooling and power generation; processing and design approaches for nanoscale and/or biomolecular materials and interfaces; and medical pathogen countermeasures.

(U) **Program Accomplishments and Plans:**

(U) FY 1997 Accomplishments:
- Electrochemistry. ($8.5M)
  - Developed and tested a thermally integrated fuel cell stack and reformer which operated on logistics fuel.
  - Demonstrated direct oxidation, liquid-feed methanol fuel cell stack operation with performance adequate for soldier applications.
- Biomedical. ($1.6M)
  - Demonstrated simulated tissue providing physiologic response to haptic input.
- Magnetic Materials and Devices. ($1.3M)
  - Fully characterized spin transistor and other spin polarized transport devices for use in ultra-high density memory applications.

(U) FY 1998 Program:
- Electrochemistry. ($9.0M)
  - Construct and test a logistics fueled fuel cell power plant for mobile electric power applications.
  - Begin component and system study/demonstration of a direct oxidation fuel cell for replacement of military standard batteries.
  - Explore alternative sources of energy for portable power applications.
  - Develop and demonstrate thermoelectric and thermophotovoltaic materials with significantly improved performance.

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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

	DATE February 1998

APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 1 Basic Research

R-1 ITEM NOMENCLATURE
Defense Research Sciences,
PE 0601101E, Project MS-01

- Nanoscale/Biomolecular Materials. ($1.0M)
  - Exploit recent advances in materials design and processing to demonstrate nanostructural control of materials properties with an emphasis on emulating the complex microstructure and scale of biological materials.

- Pathogen Countermeasures. ($2.5M)
  - Determine one or more mechanisms a stem cell could use to link detection of a pathogen to the production by the cell of vaccines and/or therapeutics.

- Thermoelectric Materials. ($1.8M)
  - Demonstrate materials with a factor of two increase in thermoelectric figure of merit.

(U) FY 1999 Program:
- Portable Power. ($9.5M)
  - Optimize catalysts, polymeric membranes, and separator plates for high energy density fuel cell operation.
  - Brassboard testing of compact, high performance energy sources for portable power applications.
  - Demonstrate novel thermoelectric and thermophotovoltaic power generation devices based on advanced materials.

- Nanoscale/Biomolecular Materials. ($2.0M)
  - Demonstrate the applicability of nanostructural and/or biomolecular materials in Defense applications such as armor, high strength fibers, or coatings.

- Pathogen Countermeasures. ($4.2M)
  - Develop understanding of disease-causing (virulence) factors in pathogens of concern to DoD.

- Thermoelectric Materials. ($2.0M)
  - Develop thin film cooler utilizing quantum well structures.

(U) **Program Change Summary:**

	(In Millions)	FY 1997	FY 1998	FY 1999
President's Budget		11.7	15.0	17.7
Appropriated		11.2	13.3	N/A
Current Budget		11.4	14.3	17.7

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

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| APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 1 Basic Research | R-1 ITEM NOMENCLATURE
Defense Research Sciences,
PE 0601101E, Project MS-01 |

(U) **Change Summary Explanation:**

FY 1997 Increase reflects minor program repricing.
FY 1998 Increase reflects expansion of efforts under the pathogen countermeasures program.

(U) **Other Program Funding Summary Cost:** N/A

(U) **Schedule Profile:** N/A

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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

DATE February 1998

| APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 2 Applied Research | | | | R-1 ITEM NOMENCLATURE
Next Generation Internet,
PE 0602110E, R-1 #7 | | | |

COST *(In Thousands)*	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Next Generation Internet NGI-01	0	40,453	40,000	40,000	0	0	0	0	N/A

(U) **Mission Description:** The Next Generation Internet (NGI) initiative has three goals: (1) promote experimentation with the next generation of networking technologies; (2) connect universities and national laboratories with high speed networks that are 100 - 1000 times faster than today's Internet; and (3) demonstrate revolutionary applications that meet important national goals and missions. The principal agencies involved in this initiative are DARPA, NSF, NIST and NASA. These agencies will share in funding this research and development effort. The DARPA activity will be aimed at part of the first two goals. DARPA will demonstrate end-to-end network connectivity at 1+ gigabits-per-second for 10 or more NGI sites. The network technologies to be addressed include multi-gigabit broadband networks, guaranteed quality of service mechanisms, and integrated network management. These technologies will be demonstrated in an NGI developed testbed environment.

(U) **Program Accomplishments and Plans:**

(U) FY 1997 Accomplishments: New start in FY 1998.

(U) FY 1998 Program:
- Develop, design and initiate building the NGI testbed. ($5.0M)
- Create ultra high bandwidth Wavelength Division Multiplier (WDM) connections for Next Generation Internet (NGI) testbed (Supernet). ($15.0M)
- Define quality of service architecture and implement initial operating system kernel for the Supernet testbed. ($15.0M)
- Define 10 gigabit-per-second optical switching transmission protocols and network and resource management strategy. ($3.5M)
- Execute Congressionally mandated adjunct to the NGI program. ($2.0M)

(U) FY 1999 Program:
- Implement 10 gigabit-per-second, multi wave optically switched WDM technology in NGI testbed. ($5.0M)
- Implement an alpha-level prototype high speed optical multiplexor and protocol structure. ($15.0M)
- Expand testbed to DoD laboratories and to 10 gigabit-per-second links. ($5.0M)
- Implement prototype network management system. ($10.0M)

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE	February 1998

APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 2 Applied Research	Next Generation Internet, PE 0602110E, Project NGI-01

- Define application program interfaces for information management and collaborative applications. ($5.0M)

(U) **Program Change Summary:** *(In Millions)*

	FY 1997	FY 1998	FY 1999
President's Budget	0	40.0	40.0
Appropriated	N/A	40.5	N/A
Current Budget	0	40.5	40.0

(U) **Change Summary Explanation:** N/A

(U) **Other Program Funding Summary Cost:** N/A

(U) **Schedule Profile:** N/A

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Computing Systems and Communications Technology, PE 0602301E, R-1 #12

COST (In Thousands)	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Computing Systems and Communications Technology	**304,766**	**309,037**	**417,723**	**368,779**	**412,248**	**436,840**	**446,548**	**Continuing**	**Continuing**
JASON ST-01	1,169	1,291	1,200	1,200	1,200	1,200	1,200	Continuing	Continuing
Intelligent Systems & Software ST-11	86,349	91,981	81,700	92,026	117,683	125,007	126,591	Continuing	Continuing
High Performance and Global Scale Systems ST-19	166,059	157,784	193,314	191,635	193,891	193,551	198,329	Continuing	Continuing
Software Engineering Technology ST-22	15,994	16,609	17,100	17,600	18,100	18,700	19,300	Continuing	Continuing
Information Survivability ST-24	35,195	41,372	54,509	55,715	60,146	57,154	59,900	Continuing	Continuing
Adaptive Computing ST-25	0	0	0	10,603	21,228	41,228	41,228	Continuing	Continuing
Joint Infrastructure Protection ST-26	0	0	69,900	0	0	0	0	0	TBD

(U) **Mission Description:** This program element is budgeted in the Applied Research Budget Activity because it funds projects directed toward the application of advanced, innovative computing systems and communications technologies.

(U) The High Performance and Global Scale Systems project is developing technologies that will lead to successive generations of more secure, higher performance, and more cost-effective microsystems, associated software defense technologies, advanced mobile information technology, and prototype experimental applications that are critical to operations and federal needs.

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(U) The efforts funded in the Intelligent Systems and Software project focus on the development of new information processing technology concepts that lead to fundamentally new software and intelligent system capabilities. Emphases are in software composition technology, active sensors and central strategies, and situational analyses.

(U) The Software Engineering Technology project supports the Software Engineering Institute (SEI) that works to transition state-of-the-art technology, and best practices to improve the acquisition, engineering, fielding, and evolution of software-intensive DoD systems.

(U) The Information Survivability project develops the technology base underlying the solutions to protecting DoD's mission-critical information systems against attack upon or through the supporting infrastructure. These technologies lead to generations of stronger protection, higher performance, and more cost-effective security solutions scalable to several thousand sites and to high-performance computing technologies.

(U) The Joint Infrastructure Protection project examines the physical and national cyber defense threats to and vulnerabilities of critical infrastructures in the United States through research in the areas of information assurance and "other areas" of infrastructure protection such as intrusion monitoring and detection systems, information collection technologies, and data reduction and analysis tools.

(U) The JASON Group supports studies for the national security community.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Computing Systems and Communications Technology, PE 0602301E

COST (In Thousands)	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
JASON ST-01	1,169	1,291	1,200	1,200	1,200	1,200	1,200	Continuing	Continuing

(U) **Mission Description:** This project supports the JASONs, an independent group of distinguished scientists and technical researchers that provides analysis of critical National Security issues. JASON membership is carefully balanced to provide a wide spectrum of scientific expertise and technical analysis in theoretical and experimental physics, materials, information sciences, and other allied disciplines. The JASON process ensures senior government leaders have the full range of U.S. academic expertise available on issues critical to National Security involving classified and unclassified information.

(U) **Program Accomplishments and Plans:**

(U) **FY 1997 Accomplishments:**
- Continued studies in: Counter proliferation of chemical and biological weapons; sensors to support small unit operations; high bandwidth urban communications; characterization of underground facilities; novel energetic materials; small scale propulsion; and ultra scale computing.

(U) **FY 1998 Program:**
- Continue studies of interest to DoD in multiple disciplines such as: Counter proliferation of chemical and biological weapons; advanced sensor technologies; advanced computing; land mine detection; battlefield information systems; battlefield planning and control; small unit operations; military communications; and novel materials.

(U) **FY 1999 Program:**
- Continue studies of interest to DoD.

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APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 2 Applied Research	Computing Systems and Communications Technology, PE 0602301E, Project ST-01

(U) **Program Change Summary:** *(In Millions)*

	FY 1997	FY 1998	FY 1999
President's Budget	1.2	1.2	1.2
Appropriated	1.2	1.2	N/A
Current Budget	1.2	1.3	1.2

(U) **Change Summary Explanation:**

FY 1998 Increase reflects minor program repricing.

(U) **Other Program Funding Summary Cost:** N/A

(U) **Schedule Profile:** N/A

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| APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research | R-1 ITEM NOMENCLATURE Computing Systems and Communications Technology, PE 0602301E |

COST *(In Thousands)*	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Intelligent Systems and Software ST-11	86,349	91,981	81,700	92,026	117,683	125,007	126,591	Continuing	Continuing

(U) **Mission Description:** This project develops new information processing technology concepts that lead to fundamentally new software and intelligent systems capabilities. This will enable advanced information systems to more effectively accomplish decision-making tasks in stressful, time sensitive situations and create efficient software intensive defense systems.

(U)   Major areas of technical emphasis are: (a) software composition technology including languages, algorithms, components, object brokers and repositories, software design tools, and advanced software engineering environments; (b) active sensors and control strategies that leverage software-based intelligent processing to: acquire sensory information, including advanced airborne video surveillance (AVS), and prepare it for higher order processing by situation awareness and analysis tools; and to provide sophisticated feedback and control of subsystems and collections thereof; (c) situation analysis and presentation tools that provide for: the intelligent integration of information from heterogeneous sources; interactive problem solving, planning, scheduling and decision analysis; and the integration and application of emerging language understanding to address both C4I and Intelligence community needs.

(U)   **Program Accomplishments and Plans:**

(U)   FY 1997 Accomplishments:

- Continued development of human-computer interaction, heterogeneous testbed products and insertion; demonstrated technologies within the context of JTF-97, STOW-97 simulation setup and Advanced Logistics Program (ALP). ($6.2M)
- Experimentally evaluated methods for building information detection filters from text, and baseline topic concept recognition from radio news broadcasts. ($2.6M)
- Evaluated distributed design tools and demonstrated multi-agent systems for capture of collaborative design history. ($12.8M)
- Developed modular Human Language Technologies to support easy, low-cost, rapid technology transfer and application development for Document Understanding, Machine Translation, and Speech Understanding; demonstrated text understanding of operational message traffic for USACOM crisis planning. ($5.0M)

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Computing Systems and Communications Technology, PE 0602301E, Project ST-11

- Developed performance enhancements in scheduling algorithms and advanced architectures planning and decision aids systems. ($7.3M)

- Extended Architecture Description Language for complex systems (ACME) to include context information; published version 2 of ACME description. ($5.1M)

- Implemented distributed dynamic language and real-time dynamic language; demonstrate Dylan compiler and ADA to JAVA byte code translator. ($4.5M)

- Demonstrated initial web-structure configuration management capability. ($3.9M)

- Supported software initiatives at the National Applied Software Engineering Center (NASEC); Johnstown, PA. ($8.8M)

- Developed new image understanding technologies for image exploitation, automatic population of geospatial databases, and video surveillance and monitoring to enhance battlefield awareness. ($5.6M)

- Performed university research toward development of automated target recognition technologies that operate effectively under difficult circumstances involving obscuration, camouflage, and urban settings. ($1.0M)

- Developed and demonstrated, in the Intelligent Integration of Information area, techniques to integrate disparate data sources for logistics planning, command and control, and battlefield awareness. ($11.5M)

- Developed a library of knowledge base components and a suite of interoperable editing tools to support the creation and maintenance of High Performance Knowledge Bases in battlefield awareness, crisis management and military command and control. ($7.8M)

- Developed site-monitoring technology and testbed for evaluating utility of automated tools for image analysts. ($1.7M)

- Executed Congressionally directed Reuse Technology Adoption Program (RTAP). ($2.5M)

(U) FY 1998 Program:

- Software Composition. ($32.6M)
  - Integrate selected Rapid Design Exploration and Optimization (RaDEO) design computation tools to demonstrate robust multi-disciplinary design. Demonstrate a 5x reduction in early design trade-off time by combining qualitative & quantitative models.
  - Demonstrate web-based toolkit of representation, analysis and generation tools.
  - Initial demonstration of ability to incrementally re-analyze a system through combination of path analysis and prior test results.
  - Release real-time dynamic language system for use by Integrated Feasibility Demonstration teams.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Computing Systems and Communications Technology, PE 0602301E, Project ST-11

- Complete Computer Aided Education and Training Instruction (CAETI) effort to enhance ongoing collaborative learning environments; evaluate collaborative virtual workspaces; and integrated tools architecture for DoD testbeds.
- Execute Congressionally mandated Reuse Technology Application Program (RTAP).
- **Active Sensors and Controls.** ($22.2M)
  - Support software initiatives at the National Applied Software Engineering Center (NASEC); Johnstown, PA.
  - Develop, demonstrate, and evaluate image understanding technologies for image exploitation, automatic population of geospatial database, video surveillance and monitoring, and automatic target recognition to enhance battlefield awareness.
  - Build multi-year advanced technology development plan and demonstrate laboratory prototypes for precision video georegistration, multiple target surveillance and military activity monitoring subsystems. Complete system design for integrated advanced Airborne Video Surveillance (AVS) systems and establish concept of operations working group from government video surveillance users.
- **Situation Analysis and Presentation.** ($37.2M)
  - Develop initial prototypes for multi-language text extraction and audio transcription where performance is baselined against that of human operators.
  - Continue development of modular Human Language Technologies to support easy, low-cost, rapid technology transfer and application development for Document Understanding, Machine Translation, and Speech Understanding.
  - Integrate human-in-the-loop, automated planning, and decision aids techniques for managing military command and control processes in quickly-changing operational settings; demonstrate capabilities to generate, assess, and select among multiple alternative plans in time currently required to generate one plan.
  - Use unified ontologies in tools for focused knowledge acquisition; extend learning methods; and add new high-performance, problem-solving methods to the High Performance Knowledge Base library for battlefield awareness, crisis management, and military command and control.
  - Develop, in the Intelligent Integration of Information area, tools and techniques to enable the rapid construction of information fusion, aggregation, and summarization software to filter, access, and integrate information from 100's of disparate, heterogenous, distributed data sources.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Computing Systems and Communications Technology, PE 0602301E, Project ST-11

(U) **FY 1999 Program:**

- **Software Composition.** ($25.7M)
  - Conduct Instrumented Feasibility Demonstration, (IFDs) of evolutionary design technologies; IFD participants include USTRANSCOM, Joint STARS, and B2 software maintenance.
  - Investigate active approaches to software composition, with emphasis on: aspect-oriented programming; on-the-fly component generation & interconnection; and module self-evaluation and configuration.
  - Demonstrate a 2X reduction in detailed design by integrating Design Web and Computational Tools made for multi-disciplinary optimization.

- **Active Sensors and Controls.** ($27.5M)
  - Integrate most successful new image understanding and automatic target recognition technologies into feasibility demonstrations for video image exploitation, synthetic environments, and video surveillance; demonstrate & evaluate impact of embedded image understanding technologies on battlefield awareness.
  - Evaluate software-based control mechanisms & their interaction across subsystem boundaries; explore novel approaches to predicting and regulating the collective behavior of mobile software entities.
  - Develop and integrate airborne systems and demonstrate military point activity monitoring and accurate georegistration of video frames. Perform laboratory demonstrations of target tracking across scene occlusions and the creation of large orthomosaics from video with 5-meter accuracy.

- **Situation Analysis and Presentation.** ($28.5M)
  - Develop language comprehension technology to provide extraction of content and production of summary information focused on information access, manipulation and creation tasks in order to demonstrate improved readiness for military planning and situation awareness.
  - Develop and demonstrate fully automatic algorithms to determine the structure of radio and TV news broadcasts in several languages allowing military planners and intelligence analysts to detect and track emerging topics.
  - Develop and demonstrate a large, integrated situation assessment knowledge base through reuse of knowledge base components from heterogeneous sources.
  - Demonstrate the utility of man-machine planning and execution control against an aggressive adversary in a realistic simulation of an operational environment.
  - Demonstrate and transition Intelligent Integration of Information tools and techniques to enable the rapid construction of large scale information associates to filter, access, and integrate information from 100's of disparate, heterogenous data sources.

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APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
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(U) **Program Change Summary:** (In Millions)

	FY 1997	FY 1998	FY 1999
President's Budget	98.4	105.5	103.0
Appropriated	90.1	98.6	N/A
Current Budget	86.3	92.0	81.7

(U) **Change Summary Explanation:**

FY 1997 Decrease reflects reprogramming associated with the SBIR program and minor repricing.
FY 1998 Decrease reflects accelerated completion of the Human Computer Interaction effort stand-alone program and integration of the related technologies into other intelligent systems programs.
FY 1999 Decrease reflects realignment of program priorities.

(U) **Other Program Funding Summary Cost:**   N/A

(U) **Schedule Profile:**   N/A

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Computing Systems and Communications Technology, PE 0602301E							

COST (In Thousands)	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
High Performance and Global Scale Systems ST-19	166,059	157,784	193,314	191,635	193,891	193,551	198,329	Continuing	Continuing

(U)   **Mission Description:** This project develops the computing, networking, and associated software technology base underlying the solutions to computational and information-intensive applications for future defense and federal needs. These technologies will lead to successive generations of more secure, higher performance, and more cost-effective microsystems, associated software technologies, advanced mobile information technology and prototype experimental applications critical to defense operations. The project is comprised of the following components:

- The Global Mobile Information Systems effort will enable mobile users to access and utilize the full range of services available in the Defense Information Infrastructure. To achieve this goal, it will develop nomadic technologies and techniques at the applications, networking, and wireless link/node levels.

- The Systems Environments component develops scalable software which is tailored toward easing the use of systems by application programmers. This includes languages, run-time services, scalable software library technologies, and experimental applications.

- The Networking component develops active networking technologies and associated network management capabilities. Research is coordinated with network technology and Service deployments made by DoD, NASA, and other federal agencies.

- The Scalable Systems and Software component develops software and hardware technologies leading to a secure scalable computing and communications technology base for systems configured over a wide performance range, from mobile handheld devices to desktop workstations to large-scale, distributed systems.

- The Embeddable Microsystems component is pioneering the critical technologies that will enable the widespread penetration of information-based microsystems. Microsystems are the critical bridge that leverage other DARPA technology in low-power processes, advanced packaging, materials, electronic componentry, networking and interfaces to develop the architecture and building blocks of the most advanced tactical devices and systems.

- Defense Information Integration and Visualization combines state-of-the-art computing and information technologies to enable automated and comprehensive situation analysis based on the synthesis of battlefield and repository-based information sources. This includes projects which accelerate technology transition of advanced research to intelligence, command and control, and other major DARPA and DoD programs. Technologies

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addressed include: information management, integration of federated repositories, multicast information distribution, and multimedia collaboration and visualization.

(U) Each of the above components of this program will integrate capabilities developed under the Information Survivability initiative (Project ST-24) to satisfy defense requirements for secure systems.

(U) **Program Accomplishments and Plans:**

(U) FY 1997 Accomplishments:

• Global Mobile Information Systems. ($15.8M)
   – Developed web-based proxy that adaptively compresses image formats during retrieval by mobile users.
   – Developed adaptive networking extensions to Internet transport protocol (TCP/IP) in support of mobility.
   – Demonstrated multimedia hand-held node (InfoPad) with high speed wireless access.
   – Published initial radio Application Programming Interface (API) definition.
• Systems Environments. ($14.1M)
   – Enabled structural dynamics applications using scalable software library technology.
   – Demonstrated scalable Advanced Distributed Simulation enabling STOW-97 to utilize 50,000 entities.
   – Defined HPC++ language and runtime services with extensions for data and task parallel exploitation of concurrency.
• Networking. ($26.2M)
   – Network Engineering.
     * Developed network grade of service capability based on expected capacity profiles.
   – High Performance Networking.
     * Completed design of 6.5M packet/sec router with 16 ports and embedded test capabilities.
   – Active Networks.
     * Defined interim SmartPacket format for early interoperability demonstrations.
• Scalable Systems and Software. ($28.7M)
   – Scalable Computing.
     * Demonstrated integration of parallel communication and processing; and MAGIC shared memory accelerator chip.

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- Ultrascale Computing.
  * Designed quantum computation protocols that encode information in a manner that is resistant to error propagation.
  - QUORUM.
    * Released toolkit for automatic operating system (OS) specialization; demonstrated 50% reduction in protocol and file system computer processing unit (CPU) requirement using customized OS extensions.

- Microsystems. ($31.0M)
  - Microsystems Design.
    * Released comprehensive complex system design benchmark suite.
    * Developed reliability and testability models for use in synthesis libraries.
    * Demonstrated two-site parallel processing design collaboratories.
  - Adaptive Computing Systems.
    * Developed 1 million gate standard form factor boards and hybrid system prototypes using configurable component technology.
    * Automated process of template design and integration (for Automated Target Recognition (ATR) library templates).

- Defense Technology Integration and Infrastructure. ($34.5M)
  - Information Management.
    * Developed protocols and object identifier system to support interoperable access to object-based information repositories.
    * Demonstrated use of automated English/Korean translation in defense environment.
  - Intelligent Collaboration and Visualization.
    * Developed initial design of session management architecture.
    * Demonstrated multimedia annotation for graphical representations, shown through a collaborative application where a user can attach multimedia comments to objects in a 2-D/3-D graphical space and where collaborating users can review and add to these annotations.
  - Prototype Distributed System of Systems.
    * Demonstrated use of Wave Division Multiplexing (WDM) technology within DARPA/DISA advanced technology testbed linking multiple defense agencies.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE High Performance and Global Scale Systems, PE 0602301E, Project ST-19

- Embeddable Computing. ($11.8M)
  - Completed technology insertion efforts involving use of embedded systems technology for ATR, AEGIS HiPer-D (NSWC), medical imaging, Adaptive Beamforming (NUWC), and Airborne Early Warning applications.
  - Demonstrated use of Message Passing Interface (MPI) on embeddable platform; published draft of real-time MPI specification and MPI-1 validation suite.

- Multithread Architectures. ($4.0M)
  - Executed congressionally directed program.

(U) FY 1998 Program:

- Global Mobile Information Systems. ($14.9M)
  - Demonstrate middleware services for adapting applications to changing infrastructure resources.
  - Develop advanced algorithms and components for waveform processing at untethered nodes.
  - Develop software modules for reconfigurable radios.
  - Conduct integrated technology demonstrations.

- Systems Environments. ($14.7M)
  - Demonstrate experimental versions of new iterative solvers for radar cross-section modeling; languages and runtime services supporting parallel applications such as Advanced Distributed Simulation; and HPC++ languages and runtime services supporting both task and data parallelism.

- Networking. ($21.4M)
  - Networking Engineering.
    * Demonstrate improvements in resource utilization based on real-time planning and dynamic adaption.
    * Initiate efforts to develop predictive network management based on faster than real-time simulation capability.
  - Active Networks.
    * Implement prototype of Enhanced Networking Services utilizing composable modules.
    * Complete prototype implementation of node execution environment; of fast compiler for SmartPacket Methods; and of basic management functions.
    * Initiate operation of wide area Active Network on prototype platforms.

- Scalable Systems and Software. ($40.0M)
  - Scalable Computing.

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* Microsystems. ($28.5M)
  - Microsystems Design.
    * Demonstrate formal methods for microprocessor verification.
    * Demonstrate integrated environment spanning atomic to macroscopic level models for design of advanced microcomponents.
    * Multisite demonstration of process analysis collaboratory.
  - Adaptive Computing Architectures.
    * Develop novel subsystem designs that use configurable component technology to realize low-power, hybrid, reduced overhead prototypes.
    * Demonstrate adaptive template matching concept through software prototype capable of automated runtime remapping.
    * Demonstrate highly efficient, parallel nodes; auto-parallelization of file input/output (I/O) for scalable systems; first node-level performance of ultra-low-power systems; and distributed, shared-memory support for a commodity processor.
  - Ultrascale Computing.
    * Design, model, and assess quantum-to-Si hardware and software interface; and language for expressing amorphous algorithmic computations.
    * Demonstrate 256-component addressed array of molecular computational mechanisms; and evaluate surface patterning mechanisms for culturing neural components on silicon.
  - QUORUM.
    * Develop quality-of-service negotiation protocols; and adaptive resource discovery protocols.
    * Demonstrate coarse- and fine-grained performance-driven resource allocation mechanisms, achieving performance within 30% and 50% of optimal.

* Defense Technology Integration and Infrastructure. ($23.3M)
  - Information Management.
    * Develop algorithms to effectively search collections of documents for words used only in restricted senses; and design query and preference languages incorporating similarity and value filtering.
    * Investigate statistical co-occurrence techniques for texture classification of images.
  - Intelligent Collaboration and Visualization.
    * Develop initial library of collaboration middleware for data sharing, coupling and coordination.
    * Demonstrate real-time capability to discover relevant collaborators using graph matching algorithms.

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* Demonstrate initial capability for teams to control shared, time-varying visualization models.
* Demonstrate initial capability for semantic access to timed event streams and multimedia archives.

● Embeddable Computing. ($15.0M)

- Demonstrate utility of embeddable computing technology in missile/avionics and unmanned undersea vehicle (UUV) real-time testbeds.
- Demonstrate extremely high-density Digital Signal Processing (DSP) packaging and thermal dissipation technologies capable of achieving 1 TFlop/cu. ft.
- Complete space-time adaptive processing (STAP) algorithm tools and libraries.
- Develop domain-specific development tools with visualization capability and MatLab compatible system generator.

(U) FY 1999 Program:

● Global Mobile Information Systems. ($18.8M)

- Demonstrate application support for distributed computing in mobile environments; continuous multi-tier networking across wireless domains; and integrated high data-rate untethered node.

● Systems Environments. ($16.9M)

- Performance-Driven Compiler and Library Technologies.
  * Demonstrate experimental scalable image processing application using DARPA embedded systems platform.
- Load Adaptive Run-time Environments.
  * Release prototype subsystem supporting adaptive resource allocation and consumption in response to changing workload and resource availability.

● Networking. ($34.3M)

- Networking Engineering.
  * Investigate alternative approaches to large scale network management and engineering including self-organizing simulation technology.
  * Demonstrate reliable service foundation for routing, multicast, and location-aware Enhanced Networking Services on multiple high end workstations.
- Active Networks.
  * Extend operation of Active Network technology to traverse ~10 sites of ~10 switches; each using SmartPackets and composite protocols.

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* Demonstrate node execution environment supporting resource protection, security, and survivability functions.

- Prototype Distributed Systems.
  * Transfer global scale technologies into defense specific, distributed operational testbeds, including SC-21 prototype for Navy shipboard communications.
  * Evaluate the scalability and performance issues related to mobility, multicast communication and active networking.

• Scalable Systems and Software. ($37.5M)

- Ultrascale Computing.
  * Conduct system-level design and simulation study of a computation model based on large amorphous arrays; demonstrate prototype array with >1,000 elements.
  * Establish role of Nuclear Magnetic Resonance (NMR) technologies in development of quantum computing research medium.

- Data Intensive Computing Systems.
  * Design instruction set extensions and storage components to allow Defense applications to specify whether operations are executed in the central processor or in logic circuits embedded in the memory hierarchy.

- QUORUM.
  * Integrate multi-attribute quality-of-service specification language architecture.
  * Demonstrate path-based propagation of quality of service constraints across layer and network boundaries.

• Embeddable Microsystems. ($28.2M)

- Tactical Signal Processing.
  * Publish benchmarks for embedded signal processing.
  * Demonstrate enabling technologies, including: Discrete Fourier Transform (DFT) chips based on clockless logic, Single Instruction Multiple Datastream (SIMD) and multi-DSP board designs, 4 Gbps channels and high speed configurable interconnect.
  * Develop compiler and code generators to permit retargeting of commercial signal processing tools to suit tactical signal processing environments.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE High Performance and Global Scale Systems, PE 0602301E, Project ST-19

- Hybrid Information Appliances.
    * Evaluate alternative mechanisms for embedded logic, storage & communications subsystems that incorporate biological materials with potential to achieve size, weight and power reductions of >10 over electronic-only equipment.
    * Demonstrate communication channels which transduce electrical/optical/magnetic signals to chemical and/or biological processes.
- Hands-Free Interfaces.
    * Develop algorithms to deal with high noise conditions for speech recognition; demonstrate and evaluate use of dialogue-based architectures within embedded environments.

- Adaptive Computing Architectures. ($27.6M)
- Debug and validate novel, configurable component technologies and architectures; demonstrate use of adaptive building blocks in wireless radio applications.
- Demonstrate 100x user-level software performance improvement over commodity microprocessors on challenge problems; release new algorithm design software environment optimized to leverage adaptive technology.

- Defense Information Integration and Visualization. ($30.0M)
- Information Management.
    * Develop framework for federation of text, image and relational databases.
    * Demonstrate translingual search aids for military type documents in English, Korean and a European language.
    * Validate design of secure repository architecture for digital objects up to 100 megabytes in size.
- Intelligent Collaboration and Visualization.
    * Integrate application-specific and generic collaboration middleware.
    * Develop Adaptive Session Management middleware, leveraging multicasting technology, that adjusts to variations in bandwidth, connectivity, access portal, team composition, and task.
    * Develop tools that enable teams and individuals to: retrieve situation and task relevant information from static and dynamic archives containing a record of experiences from multi-sensory sources; and adjust team dynamics in real-time in response to changes in mission and situation.

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APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 2 Applied Research	High Performance and Global Scale Systems, PE 0602301E, Project ST-19

(U) **Program Change Summary:**   *(In Millions)*

	FY 1997	FY 1998	FY 1999
President's Budget	191.2	169.6	201.0
Appropriated	175.1	154.6	N/A
Current Budget	166.1	157.8	193.3

(U) **Change Summary Explanation:**

FY 1997   Decrease reflects program reductions in Networking Systems and Scalable Systems and Software, inflation rescission, and reprogramming for SBIR program.

FY 1998   Increase reflects reprogramming to partially offset Congressionally mandated undistributed reductions to ensure proper program pricing.

FY 1999   Decrease reflects program reprioritization and repricing.

(U) **Other Program Funding Summary Cost:**   N/A

(U) **Schedule Profile:**   N/A

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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

	DATE	February 1998

APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Computing Systems and Communications Technology, PE 0602301E

COST (In Thousands)	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Software Engineering Technology ST-22	15,994	16,609	17,100	17,600	18,100	18,700	19,300	Continuing	Continuing

(U) **Mission Description:** Software is key to meeting DoD's increasing demand for high quality, affordable, and timely national defense systems. There is a critical need to rapidly transition state-of-the-art technology and best practices to improve the acquisition, engineering, fielding, and evolution of software-intensive DoD systems. This project funds the technology transition activities of the Software Engineering Institute (SEI) at Carnegie Mellon University. The SEI is a Federally Funded Research and Development Center (FFRDC) sponsored by the Office of the Under Secretary of Defense for Acquisition and Technology. It was established in 1984 as an integral part of the DoD's software initiative to identify, evaluate, and transition high leverage technologies and practices and to foster disciplined software engineering practices by DoD acquisition and life cycle support programs and within the industrial base where the bulk of defense software is produced. The Institute works across government, industry, and academia to: (1) improve current software engineering systems; (2) facilitate rapid, value-added transition of technology to practice; and (3) evaluate and calibrate emerging technologies to determine their potential for improving the evolution of software-intensive DoD systems.

(U) The SEI enables the exploitation of emerging software technology by bringing engineering discipline to software acquisition, development, and evolution. The SEI focuses on software technology areas judged to be of the highest payoff in meeting defense needs. FY 1997 and FY 1998 focus areas were: Technical Engineering Practices (including Information Survivability practices, Architecture-centered Software Engineering, and COTS-Based Software Engineering), Enhanced Software Management Capabilities (including Software Process Improvement and Capability Maturity Model Integration), and Accelerating Adoption of High Payoff Software Technologies.

(U) **Program Accomplishments and Plans:**

(U) FY 1997 Accomplishments:

- Technical Engineering Practices: Developed pilot models for assessing information system survivability and provided countermeasures for information warfare against software-intensive systems including: security risk taxonomy and guidelines and security analysis tool kits. Established techniques for applying architecture-centered technologies to evaluate and predict properties of software systems, including performance, reliability, and security properties. Established architectures for upgrading real-time systems reliably. Provided case studies for problems and solutions in using COTS software to develop DoD systems. ($8.8M)

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	DATE February 1998

APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Computing Systems and Communications Technology, PE 0602301E, Project ST-22

- Enhanced Software Management Capabilities: Integrated and enhanced models for software processes, process improvement methods, and analytical capabilities to provide a common base for process assessments and improvement analysis. Initiated operation of a repository for DoD software measurement data and risk management experience; released software measurement handbook and risk evaluation guidebook. ($5.6M)

- Acceleration Adoption of High Payoff Software Technologies: Developed guidebook for introducing technology change into organizations. Demonstrated potential utility of collaborative process technology for enhancing cooperation in responding to information warfare attacks. ($1.6M)

(U) FY 1998 Program:

- Technical Engineering Practices: Define and document administrative process and procedures for global incident response coordination. Process guides for global incident response coordination are used by collaborating incident response teams. A vulnerability knowledge base used by response teams is enhanced to support the collection, analysis, and sharing of security incident data. Architectural patterns supporting the integration of COTS components have been identified. Attribute-specific survivability patterns for COTS-based architectures and legacy systems are demonstrated. ($9.1M)

- Enhanced Software Management Capabilities: Integrated and enhanced models for software processes, process improvement methods, and analytical capabilities to provide a common base for process assessments and improvement analysis. Initiated operation of a repository for DoD software measurement data and risk management experience; released software measurement handbook and risk evaluation guidebook. ($5.8M)

- Accelerating Adoption of High Payoff Software Technologies: Developed guidebook for introducing technology change into organizations. Demonstrated potential utility of collaborative process technology for enhancing cooperation in responding to information warfare attacks. ($1.7M)

(U) FY 1999 Program:

- Technical Engineering Practices: Architecture evaluation guidelines and tradeoff techniques demonstrated for use with survivable systems; an initial version of a security improvement tool kit developed to help system administrators protect their systems against current and emerging threats; pilot tests of an incident response collaboration support system, including an incident and vulnerability knowledge base, are conducted. Architecture evaluation techniques for COTS-based systems are being used to reduce costs and risk. ($9.4M)

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Computing Systems and Communications Technology, PE 0602301E, Project ST-22

- Enhanced Software Management Capabilities: Version 1.1 of the Integrated CMM is released, based on experience gained in the previous year. Profiles of risks experienced by a wide range of software developers are published for use by program managers. International standards are harmonized with the CMM. ($6.0M)

- Accelerating Adoption of High Payoff Software Technologies: Upgraded and expanded measurement information repository is released to define the benefits and costs of technical practices; updated courses in software engineering measurement are packaged to support DoD training needs. Collaboration with the increasing number of maturity level 4 organization produces statistically reliable measurements of the effectiveness of selected software engineering practices. ($1.7M)

(U) **Program Change Summary:** *(In Millions)*

	FY 1997	FY 1998	FY 1999
President's Budget	18.1	19.6	20.2
Appropriated	16.5	18.9	N/A
Current Budget	16.0	16.6	17.1

(U) **Change Summary Explanation:**

FY 1997   Decrease reflects minor program repricings.

FY 1998-99 Decrease reflects realignment of ancillary software efforts so that the core funding of SEI is clearly and separately displayed.

(U) **Other Program Funding Summary Cost:**   N/A

(U) **Schedule Profile:**   N/A

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| | DATE | February 1998 |

| APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 2 Applied Research | R-1 ITEM NOMENCLATURE
Computing Systems and Communications Technology,
PE 0602301E |

COST *(In Millions)*	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Information Survivability ST-24	35,195	41,372	54,509	55,715	60,146	57,154	59,900	Continuing	Continuing

(U) **Mission Description:** This project is developing the technology required to protect DoD's mission-critical systems against attack upon or through the supporting information infrastructure. These technologies will lead to generations of stronger protection, higher performance, and more cost-effective security solutions scalable to several thousand sites. Technologies developed under this project will be exploited in High Performance and Global Scale Systems (ST-19) and other programs to satisfy defense requirements for secure and survivable systems.

(U) Information Survivability focuses on early prototypes of software and hardware technologies leading to protection for large-scale, heterogeneous systems usable over a wide range of performance in diverse threat environments. High confidence networking technologies will be developed consisting of security mechanisms and value-added security services for integration into the network infrastructure. High confidence computing systems will be developed that provide modular security services and mechanisms, provide high reliability for distributed computations, and allow geographically-separated parts of an organization to interact as if they shared a common security perimeter. This also includes secure and fault-tolerant operating systems, firewalls, and system management tools. Assurance and integration tools will aid the development of high assurance and trusted systems and the ability to reason about their security properties.

(U) Survivability technologies will be developed to mitigate national and defense computing infrastructure vulnerabilities that could be exploited by an information warfare enemy. Intrusion-detection systems will allow attacks on the defense infrastructure to be detected, the damage to be assessed, and appropriate response to be taken. Technologies will be developed to allow crisis-mode operation of critical infrastructure components. Robust networking protocols will be designed to facilitate continuous operations in hostile environments.

(U) **Program Accomplishments and Plans:**

(U) FY 1997 Accomplishments:
- High Confidence Networking. ($7.9M)
  - Deployed prototype implementation of secure directory services.
  - Designed secure mobile routing services.
  - Developed secure real-time multicast protocols.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

	DATE February 1998

APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Computing Systems and Communications Technology, PE 0602301E, Project ST-24

- High-Confidence Computing. ($7.7M)
  - – Developed trusted group authorization server.
  - – Prototyped Common Object Request and Broker (CORBA)-compliant Domain and Type Enforcement technology for secure location interoperability.
- Assurance and Integration. ($6.4M)
  - – Preliminary design of wrapper technology.
  - – Definition of code-level metrics for evaluating the strength of systems against attack.
  - – Completed initial prototype of tool for white-box security evaluation with respect to a threat model.
- Survivability of Large Scale Systems. ($10.6M)
  - – Demonstrated technology for continued operation in face of network partition through use of optimistic replicated storage.
  - – Demonstrated technology for detecting the presence of malicious intruders.
- Developed microsystems design. ($2.6M)

(U) FY 1998 Program:

- High Confidence Networking. ($9.0M)
  - – Deploy secure multicast protocol.
  - – Prototype demonstration of agent execution at secure network nodes.
- High-Confidence Computing. ($9.4M)
  - – Complete middleware for end-to-end fault tolerant realtime services on LAN.
  - – Demonstrate integrated security support in prototype extensible operating system.
- Assurance and Integration. ($8.4M)
  - – Develop design tools for inferring system-level properties in composed systems.
  - – Prototype tools for refinement of secure software architectures.
- Survivability of Large Scale Systems. ($14.6M)
  - – Demonstrate techniques for detecting previously unknown attacks.
  - – Demonstrate a primitive survivable "immune system" for responding to attacks and intrusions.

(U) FY 1999 Program:

- High Confidence Networking. ($14.1M)
  - – Demonstrate secure middleware supporting distributed applications over mobile and wireless networks.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE	DATE
RDT&E, Defensewide BA 2 Applied Research	Computing Systems and Communications Technology, PE 0602301E, Project ST-24	February 1998

- High-Confidence Computing.   ($14.2M)
  - Demonstrate techniques for general pairwise tradeoffs among fault-tolerance, realtime operations and security.
  - Evaluate prototype compiler for certifying proof-carrying code.
  - Release operating system prototype supporting efficient, secure nested virtual machines.
- Assurance and Integration.   ($10.1M)
  - Complete initial wrapper-generator toolkits.
  - Demonstrate integration of security composition techniques into software engineering tools.
- Survivability of Large Scale Systems.   ($16.1M)
  - Develop techniques for diagnosing multi-agent multi-staged attack, through cooperative intrusion detection and reporting.
  - Demonstrate Adaptive Architecture for Survivable System of Systems.
  - Conduct red team exercise(s) to assess survivability of large scale systems and networks.

(U) **Program Change Summary:**   *(In Millions)*   FY 1997   FY 1998   FY 1999

President's Budget   38.1   45.8   46.1

Appropriated   34.7   41.8   N/A

Current Budget   35.2   41.4   54.5

(U) **Change Summary Explanation:**

FY 1997-98   Changes reflect minor program repricing.
FY 1999   Increase reflects funding realignment to the project in response to its high priority.

(U) **Other Program Funding Summary Cost:**   N/A

(U) **Schedule Profile:**   N/A

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DATE February 1998

APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Computing Systems and Communications Technology, PE 0602301E

COST (In Millions)	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Joint Infrastructure Protection ST-26	0	0	69,900	0	0	0	0	N/A	N/A

(U) **Mission Description:** The President's Commission on Critical Infrastructure Protection was established by Executive Order in July 1996 to examine the physical and national cyber defense threats to (and vulnerabilities of) critical infrastructures in the United States. As a result, this commission increased the DoD research and development investment for information assurance research and "other areas" of infrastructure protection (i.e., intrusion monitoring and detection systems, information collection technologies, and data reduction and analysis tools). This initiative is expected to be organized around three general thrusts: (1) development of technologies and tools for warning and detection of intrusion attempts (50%); (2) development of automatic modes for responding to intrusions once detected (25%); and (3) development of protocols and architectures which resist intrusion (25%). It is further expected that, because of its extreme timeliness and importance, this initiative will be conducted in very close partnership, if not jointly, with the Military Departments and with the full involvement of the Chief Information Officer (CIO) of each service.

(U) **Program Accomplishments and Plans:**

(U) **FY 1997 Accomplishments:** New Start in FY 1999.

(U) **FY 1998 Program:** New Start in FY 1999.

(U) **FY 1999 Program:**

- Create the National Information Warfare Warning System and Response Team. ($15.0M)
- Initiate new, near-term development efforts in intrusion detection technology. ($15.0M)
- Create the Intrusion Detection Effectiveness Metrics Testbed. ($7.0M)
- Initiate development of near-term intrusion countermeasures. ($12.0M)
- Initiate development of longer-term intrusion-resistent protocols and architectures. ($20.9M)

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APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 2 Applied Research	Computing Systems and Communications Technology, PE 0602301E, Project ST-26

(U) **Program Change Summary:**   *(In Millions)*

	FY 1997	FY 1998	FY 1999
President's Budget	0	0	0
Appropriated	N/A	N/A	N/A
Current Budget	0	0	69.9

(U) **Change Summary Explanation:**

FY 1999 New Start.

(U) **Other Program Funding Summary Cost:**   N/A

(U) **Schedule Profile:**   N/A

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DATE   February 1998

| APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 2 Applied Research | R-1 ITEM NOMENCLATURE
Biological Warfare Defense
PE 0602383E, R-1 #13 | | | | | | | |

COST *(In Thousands)*	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Biological Warfare Defense Program BW-01	0*	60,805	88,000	77,300	74,000	77,848	75,800	Continuing	Continuing

* The program received approval as a stand alone effort in the FY 1997 DoD Authorization Act and leverages activities previously funded in PE 0602712E, Project MPT-01, in FY 1996 and PEs 0601384BP, 0602384BP, and 0603384BP in FY 1997.

(U) **Mission Description:** This program element is budgeted in the Applied Research Budget Activity because it funds projects supporting revolutionary new approaches to biological warfare (BW) defense. Today, there is a tremendous mismatch between the magnitude of the biological warfare threat and the Department's ability to adequately respond. The widespread availability of bacterial, viral, and toxin stocks; minimal developmental cost and scientific expertise required; and abundance of weaponization potential comprise a sinister threat. The single largest concern, however, is from the exploitation of modern genetic engineering by adversaries to synthesize "super pathogens." Recent dramatic developments in biotechnology, which this program will leverage, promise to eliminate this mismatch.

(U) Efforts to counter the BW threat include developing barriers to block entry of pathogens into the human body, pathogen countermeasures to stop pathogen virulence and to modulate host immune response, medical diagnostics for the most virulent pathogens and their molecular mechanisms, biological and chemically-specific detectors, and consequence management tools. Program development strategies will include collaborations with the pharmaceutical, biotechnology, government, and academic centers of excellence.

(U) Pathogen countermeasures to be developed include: (1) multi-agent therapeutics against known, specific agents and (2) therapeutics against virulence pathways shared by broad classes of pathogens. Specific approaches include modified red blood cells to sequester and destroy pathogens, modified stem cells to detect pathogens and produce appropriate therapeutics within the body, identification of virulence mechanisms shared by pathogens, development of therapeutics targeting these mechanisms, and efficacy testing in cell cultures and animals.

(U) In the early stages, many illnesses caused by BW agents have flu-like symptoms and are indistinguishable from non-BW related disease. Early diagnosis is key to providing effective therapy. The advanced diagnostics efforts will develop the capability to detect the presence of infection by biological threat agents, differentiate from other significant pathogens, and identify the pathogen, even in the absence of recognizable signs and symptoms (when the pathogen numbers are low).

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APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 2 Applied Research	Biological Warfare Defense PE 0602383E, Project BW-01

(U) The ability to detect biological warfare agents on the battlefield in real time with no false alarms is a crucial requirement. To address this requirement, the program will create more efficient and effective miniature sampling technologies that concentrate contaminated air and enhance the ability to capture biological warfare agents. The program will develop a new range of antibodies or design small molecules to bind specific agents (to replace the lower affinity antibodies currently used). In order to detect that the binding of an agent has occurred, the event must be "magnified." Traditionally, this is done by tagging the antibody molecule with a fluorescent probe. This program will replace the noise-plagued fluorescent tags with Up-Converting Phosphors with the sensitivity to detect a single binding event, minimizing the size of the sample required, saving time, and decreasing the number of false positive alarms. The use of fluids as a requirement for biological agent detection will be eliminated and replaced by a miniaturized (shoe box size) time-of-flight mass spectrometer. Development of a bacterial biochip to identify genus and species without multiplying the DNA by the polymerase chain reaction (PCR) will also be developed, thereby saving 20 minutes in time to identification. Additional efforts will focus on the construction of molecular, cellular, and multicellular sensors for the rapid detection of biological threats. The cellular and tissue-based sensors have the ability to respond to both known and unknown threats and determine live vs. inactivated threat status.

(U) Mission effectiveness requires rapid, correct medical responses to biological weapon threats or attacks. A portion of this project will provide comprehensive protocols to protect or treat combatants by using current and emerging biological countermeasures. It will provide accelerated situational awareness for biological warfare events by detecting exposure to agents through an analysis of casualty electronic theater medical records and will locate and determine the most effective logistical support for providing appropriate treatment and pathogen-specific resources required to mitigate effects of the attack.

(U) **Program Accomplishments and Plans:**

(U) FY 1997 Accomplishments: N/A

(U) FY 1998 Program:

- Pathogen Countermeasures. ($43.1M)
  - Optimize the detection of specific pathogens by stem cells (in cell culture).
  - Determine the impact of modified red blood cells on vascular and immune systems.
  - Define animal models in which to test the efficacy of modified red blood cells to defend against pathogens.

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APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide	Biological Warfare Defense
BA 2 Applied Research	PE 0602383E, Project BW-01

- Develop enzymes or other active molecules which can be attached to the surface of red blood cells to detect and destroy pathogens.
- Establish a portfolio of strategies to:
  * inhibit the expression of disease-causing (virulence) factors by pathogens.
  * disrupt the disease-causing (virulence) communications between pathogens.
  * modulate the body's response to the presence of a pathogen.
  * assess feasibility of novel polymeric materials to protect against pathogen exposure.
- Assess the feasibility of an array based instrument (or other novel technologies) for multi-agent pathogen diagnosis in medical samples.

- **Sensors. ($9.7M)**
  - Develop hierarchical database of mass signatures for use in detecting selected bacteria with a mass spectrometer.
  - Investigate methods for determining biological warfare agent bacterial and viral viability (agent live or dead).
  - Demonstrate the feasibility of using giant magnetoresistance for the detection of magnetic bead-tagged pathogens.
  - Fabricate and test a wick device, an integral sample pump, and a reagent reservoir system suitable for use in a handheld Up-Converting Phosphor detector.
  - Develop a bio-chip for rapid pathogen identification.
  - Identify limiting performance variables for cells in tissue based detection schemes.

- **Consequence Management. ($8.0M)**
  - Demonstrate a biological warfare Anchor Desk that provides agent-specific biological warfare (BW) situational awareness, decision and execution support with linkages to the Logistics Anchor Desk (LAD) for BW-specific logistical information.
  - Develop agent-specific "software antibodies" for detection, protection, and treatment directives to medical personnel for BW threats that will decrease response time.
  - Develop quantitative measures of operational assessment using Medical Readiness Indicators (metrics based indicators of individual and unit level readiness) and realistic BW training algorithms to improve BW medical responses.
  - Demonstrate Enhanced Consequence Management Planning and Support System (ENCOMPASS) during BIO 911 and other exercises for command and control of biological warfare incidents.

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APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 2 Applied Research	Biological Warfare Defense PE 0602383E, Project BW-01

(U) **FY 1999 Program:**

• Pathogen Countermeasures. ($53.0M)
 - Develop a modified stem cell which can both detect and produce a prophylactic/therapeutic response to a pathogen (in cell culture).
 - Define animal models in which to test the efficacy of modified stem cells to prevent disease.
 - Determine in-vitro toxicity of modified stem cell-produced therapeutics.
 - Demonstrate in laboratory animals the efficacy of modified red blood cells to eliminate pathogens from the blood for the purpose of potential defense against biological warfare (BW) agents.
 - Determine pathogen detection and elimination efficacy for modified red blood cells with enzymes or other active molecules attached to their surfaces.
 - Create techniques to rapidly develop immunization strategies against bacterial and viral pathogens and toxins.
 - Demonstrate selected strategies (in cell culture) to:
   * inhibit the expression of disease-causing (virulence) factors by pathogens.
   * disrupt the disease-causing (virulence) communications between pathogens.
   * modulate the body's response to the presence of a pathogen.
 - Develop and test invitro cellular platforms for toxin destruction and toxin binding decoys.
 - Develop polymeric materials for pathogen protection.
 - Develop a nonspecific surfactant agent to neutralize biological threat agents.

• Advanced Diagnostics. ($12.0M)
 - Determine appropriate bodily sample types (blood, saliva, sputum, etc.) to use for diagnosis.
 - Determine which non-BW pathogens must be screened against because they mimic early BW symptoms.
 - Begin identification of probes to be used in diagnosis system.
 - Evaluate feasibility of novel technologies and sampling strategies, such as detecting bodily responses indicative of infection.

• Sensors. ($15.0M)
 - Continue development of air sampling technology for airborne biological materials.
 - Determine chemotaxonomic biomarkers for selected viral substances for detection in the mass spectrometer.
 - Demonstrate replacement of a surface-bound antibody with a "designer" small molecule for high affinity pathogen capture.
 - Complete Up-Converting Phosphors (UCP) detection system and field test.
 - Modify the prototype of a miniature biodetection system following Dugway Proving Ground test results.
 - Examine and select strategies to stabilize cell systems for long-term functional response.
 - Select cell types for the development of tissue based sensors.

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APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 2 Applied Research	Biological Warfare Defense PE 0602383E, Project BW-01

- Demonstrate the ability to modify the duty cycle of a cellular response in single cell and tissue based sensors.
- Demonstrate performance of a single cell sensor.
- Consequence Management. ($8.0M)
  - Complete development of consequence management software tools.
  - Perform additional field test of biological warfare defense attack response planning tool and electronic watchboard.
  - Demonstrate interactivity and synergism of software tool suite.
  - Transition software antibodies, biological warfare knowledge base, BW Medical Readiness Indicators, and maintenance tools to the Services.

(U) **Program Change Summary:** _(In Millions)_

	FY 1997	FY 1998	FY 1999
President's Budget	0	61.6	61.8
Appropriated	N/A	57.4	N/A
Current Budget	0	60.8	88.0

(U) **Change Summary Explanation:**

FY 1998 Increase reflects repricing of pathogen countermeasures and sensors efforts.
FY 1999 Increase reflects expansion of efforts in advanced diagnostics and in physiologically based detection.

(U) **Other Program Funding Summary Cost:** N/A

(U) **Schedule Profile:** N/A

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology PE 0602702E, R-1 #15

COST (In Thousands)	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Tactical Technology	**123,523**	**148,331**	**188,995**	**186,619**	**212,597**	**224,586**	**242,434**	**Continuing**	**Continuing**
Naval Warfare Technology TT-03	31,579	20,783	16,796	11,553	14,172	27,172	27,172	Continuing	Continuing
Advanced Land Systems Technology TT-04	22,470	20,817	35,000	38,909	46,686	55,686	60,886	Continuing	Continuing
Advanced Tactical Technology TT-06	36,447	55,091	71,534	79,524	72,728	56,728	68,728	Continuing	Continuing
Aeronautics Technology TT-07	14,694	20,235	34,000	36,000	59,011	55,000	55,648	Continuing	Continuing
Advanced Logistics Technology TT-10	18,333	21,214	21,665	10,633	10,000	20,000	20,000	Continuing	Continuing
Joint Logistics ACTD TT-11	0	10,191	10,000	10,000	10,000	10,000	10,000	Continuing	Continuing

(U) **Mission Description:** This program element is budgeted in the Applied Research Budget Activity because it supports the advancement of concepts and technologies to enhance the next generation of tactical systems. The Tactical Technology program element funds a number of projects in the areas of Naval Warfare, Advanced Land Systems, Advanced Tactical, Aeronautics, and Advanced Logistics technologies.

(U) The Naval Warfare Technology project is focusing on: High Energy Density Materials, Digital Terrain Mapping, and Command, Control, Communications and Intelligence/Synthetic Environments (C3I/SE). The High Energy Density Materials program is exploring high risk/high pay-off breakthroughs in missile propellants and explosives technologies. Digital Mapping efforts are focused on demonstrating a lightweight, broadband phased-array antenna and altitude measuring system that will produce high resolution 3D maps. In the C3I/SE program, advanced information technologies are being integrated into advanced prototype systems to provide improved battlefield awareness and dominance to mobile command centers in the field. In FY 1997, the effort was expanded to include the Collaborative Crisis Understanding program.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 1998
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology, PE 0602702E

(U)   The Advanced Land Systems Technology project is developing technologies for contingency missions and military Operations-Other-Than-War (OOTW) to make U.S. combat forces more deployable, effective, survivable, and affordable. The SLID program will develop and test a system for providing protection against missiles and projectiles with explosive warheads. The Advanced Fire Support Systems program will provide rapid response and lethality associated with gun and missile artillery, thereby increasing survivability, yet requiring fewer personnel and less logistical support.   The Unexploded Ordnance Detection program will develop sensors for the chemically specific detection of explosives or other chemicals, comparable to the effectiveness of canine olfaction detection.

(U)   The Advanced Tactical Technology project is exploring the application of compact lasers; compact high-density holographic data storage and high performance computational algorithms to enhance performance of radars, sensors, communications, and electronic warfare and target recognition and tracking systems. In addition, the project funds technologies to improve passive infrared signature suppression, tactical landing systems, miniature air-launched decoy systems, and affordable rapid response missile demonstrations.

(U)   The Aeronautics Technology project will develop and demonstrate a new family of Micro-Aerial Vehicles (MAVs). The MAVs will be an order of magnitude smaller than any operational UAV and will be useful in a wide variety of military missions from covert imaging and chemical/biological agent detection to communication enhancement. The Micro Adaptive Flow Control effort and advanced vertical take-off and landing unmanned air vehicle concepts are also funded within this project.

(U)   The Advanced Logistics project is investigating and demonstrating technologies that will make a fundamental difference in transportation and logistics. The program will define, develop, and demonstrate fundamental enabling technologies that will permit forces and sustainment materiel to be deployed, tracked, refurbished, sustained, and redeployed more effectively and efficiently than before.

(U)   The Joint Logistics Advanced Concepts Technology Demonstration (ACTD) is a program that will provide hands-on demonstrations of existing and evolving logistics tools to facilitate their introduction into the service logistics community. Initial demonstrations will focus on near-term capabilities that can operate within the Global Combat Support System. Follow-on demonstrations will integrate enhanced asset tracking and transportation models with advanced Command and Control systems under development (i.e., the Battlefield Awareness and Data Dissemination ACTD).

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research			R-1 ITEM NOMENCLATURE Tactical Technology, PE 0602702E					
COST *(In Thousands)*	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete
Naval Warfare Technology TT-03	31,579	20,783	16,796	11,553	14,172	27,172	27,172	Continuing

(Note: the table also has "Total Cost" column = Continuing)

(U) **Mission Description:** The Naval Warfare Technology project develops advanced technologies for application to a broad range of naval requirements. The enabling technologies include: Virtual prototyping and advanced modeling to radically change the DoD acquisition process through integrated product and process design; integrated ship sensor, weapons and platform technologies to demonstrate the feasibility of reduced ship manning; techniques that will reduce acquisition costs through greater reliance on commercially available components; all weather interferometric sensors for precision 3-D characterization and surveillance of littoral environment for smart Naval Fire Support (NFS) weapons; and Command, Control, Communications, and Intelligence/Synthetic Environments (C3I/SE) for littoral warfare; as well as investigations into High Energy Density Materials (HEDM) for advanced explosives and propellants.

(U) 3-D High-Resolution Digital Terrain Mapping will support the Naval Fire Support (NFS) missions in the littoral environment by development of advanced 3-D radar technologies which will enable the Commander Joint Task Force (CJTF) to obtain precise realtime 3-D maps of littoral environments. These precision 3-D maps provide accurate position information of all objects in the littoral theater and will be required for next generation smart munitions and surveillance systems. All weather interferometric sensors for precision 3-D characterization and surveillance of littoral environment will require the development of broadband planar antenna active arrays, precision attitude measurement systems using inertial navigation systems tightly coupled with space based precision frequency and time sources. This effort will also develop and demonstrate advanced radar waveforms and processing algorithms required for precision geolocation by standoff sensors.

(U) The High Energy Density Materials (HEDM) program fosters high-risk/high payoff efforts which could result in major breakthroughs in missile propellant and explosives technologies applicable to a wide variety of tactical and strategic military systems. The potential benefits include: thermodynamic properties which could result in their having two-to-six times as much propulsive/explosive energy as current state-of-the-art operational materials, the "greening" of production and use, and reduction of detectability. Missile systems with size constraints could have increased range, maneuverability for flexible targeting, and/or increased kill effectiveness due to improvements in both the propellant's thrust and the warhead's lethality (per weight and volume). The program builds on theoretical work previously sponsored by other DOD organizations. Parallel theoretical work in the kinetics and thermodynamics of specific synthesis routes being attempted will be conducted to aid in identifying chemical mechanism and synthetic

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conditions most likely to result in the desired products at useful yields. As soon as potentially useful new HEDMs are synthesized, their fundamental characteristics will be determined and related to go/no-go criteria for military propellants and explosives. This program recognizes that DOD is sponsoring a number of sound attempts to evolutionary improve propellants and explosives; and it complements those endeavors by providing some high risk excursions into pursuing materials which are theoretically possible but for which there is no currently known defined synthetic route. This program also puts unique emphasis on the product materials having some characteristics historically unimportant to propellant and explosive developers.

(U) In the Command, Control, Communication, and Intelligence/Synthetic Environment (C3I/SE) area, advanced information technologies are being integrated and applied to provide improved battlefield awareness and battlefield dominance to mobile command centers in the field (e.g., Force Commanders, Commander Joint Task Force (CJTF), and deployed Joint Special Operations Task Force (JSOTF) Commanders). The advanced prototype systems developed under this program integrate the latest technologies in high-bandwidth communications, object oriented information system, collaborative planning, intelligent database access, image processing, data exploitation, and high performance computing to address the unique (quick reaction and realtime execution) requirements of forward deployed, mobile commanders. In FY 1997, the program initiated systems design for collaborative crisis understanding and mitigation, developing tools and systems necessary to recognize, understand, forecast, and defuse potential crisis situations. The Genoa Project will substantially reduce the time necessary to form teams, analyze crisis data, and develop and brief response options. This effort is focused on the National Command Authority, National Security Council, and the National Military Command Center.

(U) The Simulation-Based Design (SBD) Program developed and tested a prototype digital knowledge environment for representing physical, mechanical, and operational characteristics of a complex system. Such an environment enables a significant positive change in the acquisition process for large, complex warfighting systems. SBD utilizes virtual prototypes in synthetic environments to enable effective, integrated product and process development. The program integrates the technologies of distributed interactive simulation, physics-based modeling, and virtual environments and applies them to the design, acquisition, and life cycle support processes of systems.

(U) In the Ship Systems Automation (SSA) Program, advanced, highly automated sensor, weapons control, and platform systems (including casualty control) have been developed and demonstrated for submarine and surface ship applications. Through evolving sequential technology demonstrations, these efforts demonstrated how an integrated collection of automated systems could achieve an order of magnitude reduction in crew size. Because personnel account for a significant portion of current ships' life cycle costs, such a reduction would lead to immediate and

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long term cost savings for ship acquisition programs. DARPA efforts in the SSA arena concluded in FY 1997, but the Navy continues to explore the concepts in its design efforts for the next generation of surface combatants.

(U) **Program Accomplishments and Plans:**

(U) FY 1997 Accomplishments:

- Conducted interim Simulation-Based Design (SBD) prototype engineering demonstration tests, in conjunction with ongoing acquisition programs of the multi-disciplinary engineering analysis capability supported by the advanced computational core architecture. ($8.4M)

- Initiated SBD prototype engineering tests of the smart product model in support of integrated life cycle requirements and analyses of an evolving maritime application. ($2.2M)

- Demonstrated automated situation assessment and fusion of a complete multi-warfare tactical scene (air, surface, subsurface), tactical planning, and self-defense capabilities for ship and associated command platforms. Also demonstrated advanced reasoning systems for platform monitoring and control, intelligent construction and presentation of platform status and planning, and automated damage control/recovery reasoning. ($6.6M)

- Project Genoa initiated the development of a software system for collaboratively constructing quantifiable crisis models and "intelligent agents" which can browse across dissimilar, existing databases. ($1.9M)

- The following activities were funded by Congressional additions to the FY 1997 President's Budget:

   - Ship Systems Automation (SSA) - Integrated the SSA Tactical Scene Operator/Associate (TSO/A) (a multi-hypothesis data fusion system which analyzes sensor data and intelligence reports and displays the surface/subsurface tactical scene) with existing combat system capabilities and conducted laboratory evaluation in preparation for testing at sea. ($2.5M)

   - Simulation-Based Design (SBD) - Made available SBD prototype software to DoD Service's beta sites and acquisition programs for use, evaluation, and feedback. ($3.0M)

   - Center of Excellence for Research in Ocean Sciences (CEROS) - Continued most promising ocean sciences efforts at the CEROS. ($7.0M)

(U) FY 1998 Program:

- Continue systems development and initiate development of a tool for rapid, collaborative option development, evaluation, and presentation; demonstrate and evaluate retrieval agents; demonstrate use of access templates and profiles; evaluate filters. Demonstrate the ability to navigate several of the most important, crisis-related databases for acquiring information on a simulated crisis. ($3.2M)

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- Evaluate ability to quantify centers-of-gravity and pressure points for option development, and demonstrate modeling capabilities at Joint Task Force ATD/Global Command and Control System Insertions. Demonstrate crisis presentation capability for prioritizing policy and plans at National Security Council/National Military Command Center and supporting intelligence agencies. ($4.4M)

- The following activities are funded by Congressional additions to the FY 1998 President's Budget:

  - Simulation-Based Design (SBD) - Continue simulation based design and virtual reality efforts, in a collaborative program with private industry, for the Gulf Coast Region Maritime Technology Center. ($2.9M)

  - Center of Excellence for Research in Ocean Sciences (CEROS) - Continue most promising ocean sciences efforts at the CEROS. ($6.8M)

- Design a system-level brassboard demonstration of a lightweight, very broadband, phased-array-antenna and attitude-measurement system capable of 3-D, high-resolution Digital Terrain Mapping. ($1.5M)

- High Energy Density Materials (HEDM). ($2.0M)

  - Finalize joint development agreements with AFOSR and Swedish Defence Research Establishment and formalize definition of overall program.

  - Initiate focused synthesis work by three or four organizations.

  - Establish parallel supporting efforts in theoretical chemistry, kinetics and thermodynamics.

(U) FY 1999 Program:

- Demonstrate initial operational capability of the data retrieval and visualization capability, initial operational capability of the crisis modeling capability, and begin installation of modeling capability and integration with data retrieval capability at CIA/NMJIC. Begin installation and integration of advanced presentation capability. ($6.6M)

- Complete initial design and initiate fabrication of a 3-D, high-resolution Digital Terrain Mapping system employing planar array covering 8 to 18 GHz in a low-cost, lightweight conformal structure, attitude-measurement system, and reconstruction algorithms. ($3.0M)

- High Energy Density Materials (HEDM). ($2.0M)

  - Continue initial synthesis and fundamental support activities.

  - Initiate development of methods to scale-up to gram quantity production.

- Initiate conceptual designs for a small submersible platform and the associated mothering approach. ($1.0M)
- Conduct utility and performance study of modular wet submarine payload options. ($1.2M)

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(U) **Program Change Summary:** (In Millions)

	FY 1997	FY 1998	FY 1999
President's Budget	32.6	12.2	28.3
Appropriated	39.6	20.7	N/A
Current Budget	31.6	20.8	16.8

(U) **Change Summary Explanation:**

FY 1997   Decrease reflects phase down of the Simulation Based Design (SBD) program and phase out of the Ship Systems Automation (SSA) Program.

FY 1998   Increase reflects program repricing.

FY 1999   Decrease reflects cancellation of Advanced Electric Ship programs and the transition/application of 3-D mapping radar technology to the Starlite program in SGT-02 of PE 0603762E.

(U) **Other Program Funding Summary Cost:**   N/A

(U) **Schedule Profile:**   N/A

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COST (In Thousands)	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Advanced Land Systems Technology TT-04	22,470	20,817	35,000	38,909	46,686	55,686	60,886	Continuing	Continuing

(U) **Mission Description:** This project is developing technologies for contingency missions and military Operations-Other-Than-War (OOTW) to make U.S. combat forces more deployable, effective, survivable, and affordable. This project supports six main efforts: Small Low-Cost Interceptor Device (SLID); a Foreign Cooperative Demonstration; Advanced Fire Support Systems; Counter-artillery Force Protection (CFP); Unexploded Ordnance Detection; and a Battle Force Tactical Operation Center.

(U) The SLID program is developing and testing a system which protects threatened systems against missiles and projectiles with explosive warheads. This system will detect, track and intercept threats such as anti-armor missiles, mortars, artillery, and top-attack sensor fused munitions at a standoff distance sufficient to render them ineffective. Applications for the SLID system include: Self-defense of vehicles; defense of high value fixed sites such as command centers, parked aircraft and radars; and, with further development, naval platforms and low-speed aircraft.

(U) The Foreign Cooperative Demonstration program has fabricated and demonstrated a new system for enhancing the survivability of armored vehicles based on technology developed by a foreign source.

(U) The Advanced Fire Support Systems program will develop and test containerized, platform independent land attack weapon systems. These systems will provide the rapid response and lethality associated with gun and missile artillery in packages requiring significantly fewer personnel, decreased logistical support, lower life-cycle costs, and having increased survivability compared to current systems. These systems will allow the military to more completely capitalize on recent advances in military doctrine and infrastructure, such as the ongoing digitization of the Army. The program will develop and demonstrate highly flexible systems including a guided projectile/munition, a remotely commanded self locating launcher, and a command and control system compatible with military doctrine.

(U) The Counter-artillery Force Protection (CFP) program will develop concepts for defending forces and civilian enclaves against air threats including high rate of fire missile artillery carrying submunitions. The program will explore advanced sensors, munitions and deployment concepts to counter this evolving threat. System concepts will be developed and analyzed.

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(U)   The Unexploded Ordnance (UXO) Detection program will develop sensors for the chemically specific detection of explosives or other chemicals characteristic of land mines and/or shallowly buried UXOs. The sensors developed under this program will provide soldiers with the effectiveness of canine olfaction detection without the logistics and other constraints imposed by the use of live animals. These chemically specific sensors will work either singly or in conjunction with other technologies such as the hyperspectral mine detector, developed under the Small Unit Operations (SUO) program that exploit different physical features.

(U)   The Battle Force Tactical Operation Center (TOC) Program is developing technology to allow tactical commanders (Battle Force or Battalion) to have non line of sight communications; tasking and control of unmanned and manned assets; fused, theatre and tactical situational understanding; and responsive, precision fires enabled by multiple sensor to multiple shooter fire control algorithms. The Battle Force TOC will present the information to the commanders utilizing full immersion, three dimensional displays in multiple, dispersed vehicles which allow operations while moving.

(U)   **Program Accomplishments and Plans:**

(U)   FY 1997 Accomplishments:
- Continued Small Low-Cost Interceptor Device (SLID) phase II effort. Conducted major sub-system tests including SLID flight tests. Prepared for live-on-live tests. ($12.6M)
- Completed the Foreign Cooperative Demonstration testing and transitioned program to the Army. ($1.8M)
- Continued chemically-specific unexploded ordnance/mine detection technology development. Prepared experiments for characterization of explosive and other related chemical contamination at minefield. Evaluated advanced algorithms and sensor fusion capabilities for multiple-sensor detection. ($8.1M)

(U)   FY 1998 Program:
- Complete development leading to live-on-live Small Low-Cost Interceptor Device (SLID) testing. Transition to the Army. ($6.9M)
- Demonstration of laboratory scale system for chemically specific detection of land mines. ($10.9M)
- Conduct initial activities in the Advanced Fire Support System development, including concept and requirements analysis of loitering platforms and unmanned missile artillery packages and baseline concept designs. ($3.0M)

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(U) **FY 1999 Program:**
- Develop detailed designs for the Advanced Fire Support System, including component demonstrations. ($8.0M)
- Field demonstration of prototype chemically specific land mine detector paired with other sensors as appropriate. ($12.0M)
- Develop active and passive survivability capabilities against unitary munitions for both vehicle and ground forces, including extension of SLID protection range for application to high value fixed sites. ($8.0M)
- The Counter-artillery Force Protection (CFP) program will define one or more system architectures, including sensors, munitions and deployment, to meet the mission needs for enclave protection against missile artillery. ($5.0M)
- Develop concepts and designs for Battle Force Tactical Oepration Centers and identify key enabling technologies. ($2.0M)

(U) **Program Change Summary:** *(In Millions)*

	FY 1997	FY 1998	FY 1999
President's Budget	22.1	26.0	30.0
Appropriated	23.2	20.6	N/A
Current Budget	22.5	20.8	35.0

(U) **Change Summary Explanation:**

FY 1997   Reduction reflects minor rephasing of the Unexploded Ordnance/Mine Detection program and minor repricing of Small Low-Cost Interceptor Device (SLID) testing.

FY 1998   Increase reflects minor repricing.

FY 1999   Increase reflects repricing of Unexploded Ordnance Program, rephasing of the Advanced Fire Support Systems program, and expansion of force protection activities.

(U) **Other Program Funding Summary Cost:**   N/A

(U) **Schedule Profile:**   N/A

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COST (In Thousands)	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Advanced Tactical Technology TT-06	36,447	55,091	71,534	79,524	72,728	56,728	68,728	Continuing	Continuing

(U) **Mission Description:** This project focuses on six broad technology areas: (a) compact, efficient, frequency-agile, diode-pumped, solid-state lasers for infrared countermeasures, laser radar and sensors; (b) compact high density holographic data storage for high bandwidth image processing and access to large data bases; (c) high performance computational algorithms for signal processing, target recognition and tracking, electromagnetic propagation, and processing of advanced materials and microelectronics; (d) precision optics components for critical DoD applications; (e) miniature air-launched decoy systems; and (f) an affordable rapid response missile demonstration.

(U) **Program Accomplishments and Plans:**

(U) FY 1997 Accomplishments:

- Compact Lasers. ($5.9M)
  - Demonstrated breadboard systems of compact high power tunable mid-infrared lasers and laser diodes operating at mid-infrared wavelengths.
  - Demonstrated breadboard tunable mid-infrared lasers with 11.5 watt output power at 10 kilohertz (kHz) pulse repetition rate.
  - Demonstrated room temperature operation of pulsed mid-infrared laser diodes.
  - Demonstrated active tracking system at mid-infrared wavelengths.
- Holographic Data Storage. ($5.1M)
  - Technology demonstration established functional limits of holographic data storage.
  - Demonstrated 1 gigabit per second at 1 million pixels per page read out for holographic data storage.
- High Performance Algorithm Development. ($11.4M)
  - Demonstrated classification performance improvement for Longbow fire control radar achieved using a wavelet classifier.
  - Applied adaptive waveform designs to radar and communication.
  - Applied multiresolution methods to image processing and formation.
  - Selected applications for development of wavelet-based detection, discrimination, and classification strategies.
  - Developed new strategies for data, sensor, and algorithm fusion for signal and image processing applications that exploit the feature extraction capability of wavelets.

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- Demonstrated orders-of-magnitude processing reductions provided by parallel implementation of fast multipole techniques to radar cross section calculations.
- Developed methods for calculating electromagnetic scattering from objects in ground clutter.
- Advanced Mathematics for Microstructural Process Control. ($4.4M)
- Enhanced strategies for physicochemical modeling of thin film vapor deposition processes that integrate process, sensing, and control considerations and provide understanding of critical microstructure issues needed to design high-quality and high yield manufacturing processes.
- Developed fast algorithms for modeling and design of large-scale, high-performance circuits.
- Precision Optics Technology. ($6.6M)
- Continued development of conformal and off-axis optical components for tactical systems.
- Developed magneto-rheological finishing for aspheres, toroids and cylinders.
- Demonstrated design tools for conformal and off-axis optical systems.
- Miniature Air-Launched Decoy (MALD). ($3.0M)
- Established MALD design specifications. Conducted low speed wind tunnel testing, critical Hardware-in-the-Loop testing, passive and active signature testing, and risk reduction testing on engine. Initiated Seek Eagle Process. Initiated detailed planning for Development Test and Evaluation (DT&E) and Operational Test and Evaluation (OT&E) flight test programs. Refined operational concept for MALD.

(U) FY 1998 Program:

- Compact Lasers. ($2.3M)
- Demonstrate compact high power tunable lasers and laser diodes at mid-infrared wavelengths.
- Develop breadboard tunable mid-infrared lasers for closed-loop infrared countermeasures.
- Holographic Data Storage. ($2.2M)
- Demonstrate 1 terabit storage capacity for functional evaluation of holographic data storage systems.
- High Performance Algorithm Development. ($11.8M)
- Implement a hybrid automatic target recognition strategy for synthetic aperture radar exploiting most advantageous features of wavelets and nonlinear partial differential equation-based methods.
- Develop application-specific wavelet-based automatic target recognition algorithms.
- Continue development of most promising strategies for data, sensor, and algorithm fusion that exploit the feature extraction capability of wavelets and apply to signal and image processing.
- Develop prototype electromagnetic scattering models for objects in ground clutter.
- Demonstrate toolboxes for generating optimal portable Fast Fourier Transforms and wavelet algorithms and apply to high dimensional synthetic aperture radar.

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- Develop mathematical approaches to developing optimal portable applications libraries for selected computational kernels required in thin film process simulations and signal processing applications.

- **Advanced Mathematics for Microstructural Process Control.** ($6.2M)
  - Develop physicochemical models for thin film vapor deposition processes that integrate process, sensing, and control considerations and provide understanding of critical microstructure issues needed to design high-quality and high yield manufacturing processes.
  - Implement fast algorithms for modeling and design of large-scale, high-performance circuits.
  - Develop reduced order physicochemical models and algorithms for real-time sensing and control of thin film vapor deposition processes.

- **Precision Optics Technology.** ($5.4M)
  - Continue development of conformal optical system components for tactical systems.
  - Complete designs of conformal optics sensor systems and down select demonstration candidate from airborne platforms or missiles.
  - Fabricate aspheric optical components and diffractive optical elements on curved substrates.
  - Demonstrate metrology tools.

- **Miniature Air-Launched Decoy (MALD).** ($18.4M)
  - Fabricate and deliver flight test vehicles.
  - Conduct flight readiness review.
  - Continue ground testing and initiate Development Test and Evaluation (DT&E) and Operational Test and Evaluation (OT&E) flight testing.
  - Begin ground and flight maintenance training and begin operational training.
  - Complete Seek Eagle process.

- **Affordable Rapid Response Missile Demonstrator (ARRMD).** ($6.0M)
  - Conduct missile concept development, including manufacturing process definition, propulsion integrated flowpath demonstration and manufacturability demonstration.
  - Define flight test plan.
  - Begin affordability assessment.
  - Perform mission assessment.

- **Facial Recognition.** ($2.8M)
  - Pursue a program to enable rapid identification of individuals in crowds.

(U) **FY 1999 Program:**

- **Compact Lasers.** ($6.8M)
  - Demonstrate room temperature long wavelength laser diodes in the 7-to-9 micrometer wavelength range.

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- Complete demonstration of compact high power tunable lasers and laser diodes at mid-infrared wavelengths.
- Develop packaged tunable mid-infrared lasers for airborne infrared countermeasures.
- Complete demonstration of laser diode arrays operating at mid-infrared wavelengths.

- Holographic Data Storage.   ($1.7M)
   - Complete program with demonstration of holographic data storage for automatic target recognition and data warehousing applications.

- High Performance Algorithm Development.   ($17.4M)
   - Demonstrate hybrid automatic target recognition strategy for synthetic aperture radar exploiting most advantageous features of wavelets and nonlinear partial differential equation-based methods.
   - Demonstrate application-specific wavelet-based automatic target recognition algorithms.
   - Validate prototype electromagnetic scattering models for objects in ground clutter.
   - Demonstrate data, sensor, and algorithm fusion algorithms for signal and image processing applications that exploit the feature extraction capability of wavelets.
   - Demonstrate fast algorithms for modeling and design of large-scale, high-performance circuits.
   - Develop prototype toolboxes for generating optimal portable applications libraries for selected computational kernels required in thin film process simulations and signal processing applications.

- Advanced Mathematics for Microstructural Process Control.   ($11.2M)
   - Validate physicochemical models for thin film processes that integrate process, sensing, and control considerations and provide understanding of critical microstructure issues needed to design high-quality and high yield manufacturing processes.
   - Validate reduced order models and algorithms for sensing and control of thin film vapor deposition processes.

- Precision Optics Technology.   ($6.9M)
   - Continue development of conformal optical system components.
   - Demonstrate near net-shape growth of conformal windows.
   - Laboratory assembly, demonstration and test of conformal sensor system for missile applications.

- Miniature Air-Launched Decoy (MALD).   ($17.0M)
   - Continue operational demonstrations, acquire limited flight clearance, and transition to Services.
   - Explore other concepts of low cost MALD airframes to fill mission areas such as reconnaissance, surveillance, NBC detection, jamming, etc.

- Affordable Rapid Response Missile Demonstrator (ARRMD).   ($10.5M)
   - Complete propulsion integrated flowpath demonstration and manufacturability demonstration.
   - Perform unit cost analysis.
   - Conduct Warfighting Analysis Lab exercises.

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(U) **Program Change Summary:**   *(In Millions)*

	FY 1997	FY 1998	FY 1999
President's Budget	46.0	64.1	62.5
Appropriated	41.2	54.8	N/A
Current Budget	36.4	55.1	71.5

(U) **Change Summary Explanation:**

FY 1997 Decrease due to rephasing of the High Performance Algorithm Development program.
FY 1998 Increase due to minor repricing.
FY 1999 Increase due to outyear funding for the Miniature Air-Launched Decoy (MALD) program and Affordable
         Rapid Response Missile Demonstration.

(U) **Other Program Funding Summary Cost:**

	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Funding for Miniature Air-Launched Decoy PE 0603750D, Advanced Concept Technology Demonstration	3.7	0.7	0.0	0.0	0.0	0.0	0.0	0.0	361.1

(U) **Schedule Profile:** N/A

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COST *(In Thousands)*	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Aeronautics Technology TT-07	14,694	20,235	34,000	36,000	59,011	55,000	55,648	Continuing	Continuing

(U) **Mission Description:** Aeronautics Technology efforts will address high payoff opportunities to dramatically reduce costs associated with advanced aeronautical systems or provide revolutionary new system capabilities for satisfying current and projected military mission requirements.

(U) A new family of Micro-Air Vehicles (MAVs) that are at least an order of magnitude smaller than current flying systems (less than 15 cm in any dimension) will be developed and demonstrated. The capability to accomplish unique military missions as diverse as covert imaging in constrained areas, biological-chemical agent detection and characterization, remote precision mines, and urban battlefield communications enhancement, will be stressed through an examination of a variety of vehicle concepts. The resulting capability should be especially beneficial in the emerging urban warfighting environment, characterized by its complex topologies, confined spaces and areas (often internal to buildings), and high civilian concentrations. The MAV program will focus on the technologies and components required to enable flight at these small scales, including flight control, propulsion and lightweight power, navigation and communications. These will build upon and exploit numerous DARPA technology development efforts, including advanced communications and information systems, high performance computer technology, Microelectro-mechanical Systems (MEMS), advanced sensors, lightweight, efficient high density power sources, and advanced electronic packaging technologies.

(U) Micro Adaptive Flow Control (MAFC) technologies enable control of large scale aerodynamic flows using small scale actuators. MAFC technologies combine adaptive control strategies with advanced actuator concepts like micro-scale synthetic jets, MEMS-based microactuators, pulsed-blowing and smart structures to cause the delay or prevention of fluid flow separation. This enables potential revolutionary performance capabilities such as low-power, adaptive flight controls for Micro Air Vehicles. MAFC technologies may also apply to larger systems such as adaptive lift-on-demand for agile missiles and uninhabited tactical aircraft, and low-drag, non-intrusive methods to aerodynamically steer projectiles for extended range and precision. Advanced flow control concepts will be explored in the context of system level performance benefits and cost assessments. MAFC technology evaluations will be made under system-relevant flow conditions, and the most promising approaches will be selected for component- or system-level demonstration.

(U) The Navy and the Marine Corps have a need for an affordable, survivable, vertical take-off and landing (VTOL) unmanned air vehicle (UAV) to support dispersed units in littoral and urban areas. The Defense Advanced Research Projects Agency (DARPA), in partnership with the Defense Airborne Reconnaissance Office (DARO), the Office of Naval

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RDT&E, Defensewide
BA 2 Applied Research

R-1 ITEM NOMENCLATURE
Tactical Technology,
PE 0602702E, Project TT-07

Research (ONR) and industry, have formulated a program to explore two innovative new vertical take-off and landing (VTOL) concepts with the potential for significant performance improvements that would satisfy stressing mission needs. The first concept is an advanced Canard Rotor/Wing (CRW) concept which offers the potential for a high speed (350 knots), rapid response capability from a VTOL unmanned air vehicle (UAV) with significant range (500 nm) and stealth improvements as compared to other VTOL concepts. Detailed design, fabrication and flight test of this scaled vehicle concept will be conducted to validate the command and control and propulsion system required for vertical take-off, landing and hover via a rotating center wing which is stopped and locked in place for efficient high speed cruise. The second concept (A160), will exploit a hingeless, rigid, in-plain rotor concept to produce a VTOL UAV with very low disk loading and rotor tip speeds resulting in an efficient low power loiter and high endurance system. This unique concept offers the potential for significant increases in VTOL UAV range (>500 nm) and endurance (>40 hours). Detailed design, fabrication and testing of this concept will be conducted to establish its reliability, maintainability and performance.

(U) **Program Accomplishments and Plans:**

(U) **FY 1997 Accomplishments:**
- Conducted studies of Micro-Air Vehicle (MAV) systems and technologies; to explore and assess operational scenarios, systems configurations and component technologies. Initiated development of MAV systems, flight enabling technologies and critical technology components. ($2.7M)
- Conducted testing of emergent aerospace concepts. ($12.0M)

(U) **FY 1998 Program:**
- Micro Air Vehicles ($14.7M)
  - Conduct design and development of functionally diverse propelled MAV systems, employing alternative technology solutions, and satisfying user-identified critical military applications. Explore and demonstrate feasibility of key flight enabling technology component and subsystems. Continue evaluation of operational MAV concepts.
  - Conduct studies of Micro Adaptive Flow Control (MAFC) technology feasibility in the context of selected system applications, including micro air vehicle flight controls and small scale aerodynamically steerable munitions. Initiate assessment of actuator effectiveness, scaling, and fabrication methodologies.
- Initiate system design and conduct full scale propulsion tests, rotor tests and flight control simulations and tests for two advanced vertical take-off and landing (VTOL) unmanned air vehicle (UAV) concepts. ($5.5M)

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R-1 ITEM NOMENCLATURE
Tactical Technology,
PE 0602702E, Project TT-07

(U) **FY 1999 Program:**

- Conduct Micro Air Vehicle (MAV) system development and fabrication. Continue exploration and demonstration of flight enabling technologies and subsystems. Initiate flight test planning for propelled systems incorporating operational templates, design flight capabilities, and mission characteristics. Initiate advanced MAV concept definition. ($13.0M)

- Continue studies of Micro Adaptive Flow Control (MAFC) feasibility for micro air vehicles. Explore MAFC applicability to larger scale flows. Initiate exploration and demonstration of MAFC actuator and controller technologies for system-relevant flow conditions. ($7.0M)

- Complete detailed designs, analysis, simulations and component tests and begin fabrication of two advanced vertical take-off and landing (VTOL) unmanned air vehicle (UAV) concepts. Two Canard Rotor/Wing (CRW) demonstrators and three A160 demonstrators will be fabricated. ($14.0M)

(U) **Program Change Summary:**   *(In Millions)*

	FY 1997	FY 1998	FY 1999
President's Budget	14.9	18.0	19.5
Appropriated	12.0	16.2	N/A
Current Budget	14.7	20.2	34.0

(U) **Change Summary Explanation:**

FY 1997 Increase reflects realignment of funds into TT-07 to continue the DP-2 program in accordance with Authorization Conference direction, and initiation of the MAV program.

FY 1998 Increase reflects repricing to expand the MAFC component of the MAV program.

FY 1999 Increase reflects application of MAFC technology to other system concepts and repricing of VTOL UAV and MAV programs.

(U) **Other Program Funding Summary Cost:**

FY 1998 $6.0M Defense Airborne Reconnaissance Office (DARO) funding provided for CRW concept demonstration.

(U) **Schedule Profile:** N/A

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COST *(In Thousands)*	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Advanced Logistics Technology TT-10	18,333	21,214	21,665	10,633	10,000	20,000	20,000	Continuing	Continuing

(U) **Mission Description:** The Advanced Logistics Project will investigate and demonstrate technologies that will make a fundamental difference in transportation and logistics. The program will define, develop, and demonstrate fundamental enabling technologies that will permit forces and sustainment material to be deployed, tracked, refurbished, sustained, and redeployed more effectively and efficiently than ever before. Currently, this is accomplished using isolated, independent, and sometimes incompatible systems, processes and data. Therefore, the very rapid replanning and redirection necessary to support missions involving simultaneous local and major regional conflicts cannot be accomplished today. The Advanced Logistics Project will address these shortcomings and enable this significant capability to be developed. In addition, the project has enormous potential for cost savings through greatly improved management of transportation and logistics assets.

(U) This project will develop automated, multi-echelon, collaborative logistical/transportation technologies that will provide warfighters with an unprecedented capability to monitor, rapidly replan, and execute the revised logistics plan as the situation requires, even while assets are enroute to the theater. The Advanced Logistics Project will focus on the following three areas: 1) Development of applications providing a technology environment that allows warfighters to rapidly understand and assess the logistics and transportation implications of a crisis situation, to generate effective plans and courses of action, to monitor a plan's execution and to use that information to re-plan; 2) Automated systems that will enable significant efficiency improvements in transportation and logistics, such as improving access to data, monitoring the condition and status of shipments, personnel, inventories, logistics assets and the infrastructure, the creation of "plan sentinels" to serve as an early warning system for plan deviations, and improved theater distribution; and 3) Development of a computer network infrastructure that allows distributed real-time visualization and interaction with all phases, elements and components of the military and commercial transportation infrastructure. The capabilities from these three areas will be integrated to demonstrate an end-to-end system solution.

(U) The Advanced Logistics Project supports joint initiatives with the Defense Logistics Agency and is coordinated with other related logistics efforts within the DoD. As these technologies mature, they will immediately transition to other joint initiatives which include: the Defense Logistics Agency Logistics Research and Development (PE 0603712S), the Joint Logistics Advanced Concept Technology Demonstration (TT-11), and eventually to the Global Command and Control System (GCCS) and the Global Combat Support System (GCSS).

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology, PE 0602702E, Project TT-10

(U) **Program Accomplishments and Plans:**

(U) FY 1997 Accomplishments:

- Continued architecture development. Demonstrated a distributed logistics planning, execution, and monitoring system concept to support inland military logistics planning/replanning from origin to port. ($6.0M)

- Conducted a feasibility demonstration of advanced technologies for logistics support planning, measurement sampling, and software systems. ($3.0M)

- Initiated proof of principle for advanced software data collection techniques (also referred to as knowledge rovers or intelligent software agents) that search the Global Information Infrastructure for relevant logistics information and data and return it to the user. Initiated development of multi-echelon collaborative logistical support technology that integrate planning, execution, monitoring and decision support systems for testing and fielding. Conducted concept formulation and initial utility demonstration of "plan sentinels" to detect plan deviations within a rapid replanning environment. Developed an integrated software framework that is reusable and reconfigurable. ($9.3M)

(U) FY 1998 Program:

- Demonstrate an integrated computer environment to support automated planning, execution and monitoring of a major force deployment from fort to port to ship load, including optimized scheduling and routing with minimal staging throughout the move. ($8.0M)

- Initiate development of plan deviation detection sentinels and predictive analysis to assist in identification of replanning opportunities. ($3.5M)

- Continue development of advanced software data collection techniques. Initiate development of a Dynamic Critical Items List for sustainment planning and execution. Continue development of multi-echelon collaborative logistical support technologies. Develop and demonstrate an initial automated coarse-grained course of action evaluation that is linked to the war plan. ($9.7M)

(U) FY 1999 Program:

- Demonstrate an integrated environment to support the planning, execution and monitoring of a unit deployment from point of debarkation through in-theater distribution, including automated infrastructure assessment and monitoring. ($10.0M)

- Develop and demonstrate the ability to negotiate the exchange of information between suppliers and buyers, including rapid, flexible item and item relationship catalogs for automated sustainment processing. ($5.0M)

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- Develop automated deviation detection and triggering of the replanning processes. Continue development of a Dynamic Critical Items List for sustainment planning and execution. Develop and demonstrate automated medium grained course of action evaluation that is linked to the war plan. ($6.7M)

(U) **Program Change Summary:**   *(In Millions)*

	FY 1997	FY 1998	FY 1999
President's Budget	17.2	25.7	27.7
Appropriated	16.8	23.2	N/A
Current Budget	18.3	21.2	21.7

(U) **Change Summary Explanation:**

FY 1997 Increase reflects minor repricing.
FY 1998 Change reflects reduction of the "plan sentinels" research effort.
FY 1999 Decrease reflects downsizing of planned number of "plan sentinels".

(U) **Other Program Funding Summary Cost:**   N/A

(U) **Schedule Profile:**   N/A

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RDT&E, Defensewide	Tactical Technology,
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COST *(In Thousands)*	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Joint Logistics ACTD TT-11	*	10,191	10,000	10,000	10,000	10,000	10,000	Continuing	Continuing

* The FY 1997 Joint Logistics Advanced Concept Technology Demonstration (JL ACTD) effort was funded by the Army in PE 0603734A. The DARPA funding under this project continues the effort and expands the tools into a joint common operating environment.

(U) **Mission Description:** The Joint Logistics ACTD is a multi-phase program which will provide an experimental environment where logisticians can evaluate maturing tools and technologies for increased operational capability. Initial efforts will integrate existing tools that exploit near real-time logistics data sources operating within the Global Combat Support System (GCSS). Key data sources include Joint Total Asset Visibility (JTAV), Joint Personnel Asset Visibility (JPAV), and Global Transportation Network (GTN). This program will also provide a migration path for evaluating advanced technologies that are being developed by other programs such as the DARPA Advanced Logistics Project (TT-10), the Battlefield Awareness and Data Dissemination ACTD (PE 0603760E, project CCC-02), the Joint Force Air Component Commander (JFACC) Program (PE 0603760E, project CCC-01), and the Advanced Joint Planning ACTD (PE 0603760E, project CCC-01). This ACTD will provide logisticians the opportunity to assess the operational impact of emerging tools and technologies. Focus areas include maintaining asset visibility and control, monitoring real time execution of plans, and re-planning logistics operations to rapidly re-prioritize and redirect combat support. The ACTD will support Commander-in Chief/Joint Task Force (CINC/JTF) and Service/Agency logisticians across the entire operational spectrum -- mobilization, deployment, employment, sustainment and redeployment.

(U) **Program Accomplishments and Plan:**

(U) FY 1997 Accomplishments: N/A

(U) FY 1998 Program:
- Define operational architecture and network requirements for employment of joint decision support tools for CINCs, Components, and Services that operate within the GCSS environment and exploit near real-time data feeds (JTAV, JPAV, GTN, etc.) into a common operating picture between operations and logistics. ($3.0M)
- Integrate initial joint logistics tool sets and field at selected demonstration sites. ($5.7M)
- Demonstrate access within GCSS environment in a joint warfighting exercise. ($1.5M)

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RDT&E, Defensewide BA 2 Applied Research	Tactical Technology, PE 0602702E, Project TT-11

(U) **FY 1999 Program:**

- Develop common user interfaces to multiple data bases [Joint Total Asset Visibility(JTAV), Joint Personnel Asset Visibility (JPAV), Global Transportation Network (GTN), etc.] for query and presentation using advanced query mechanisms and visualization tools. ($3.0M)
- Expand tool set functionality focusing on Commander-in-Chief (CINC), Component, and Service needs and integrate within the Global Combat Support System (GCSS) environment. Continue fielding at selected demonstration sites. ($5.5M)
- Demonstrate multi-echelon interoperability in a joint warfighting exercise. ($1.5M)

(U) **Program Change Summary:** *(In Millions)*

	FY 1997	FY 1998	FY 1999
President's Budget	0*	11.3	10.0
Appropriated	N/A	10.2	N/A
Current Budget	0*	10.2	10.0

(U) **Change Summary Explanation:** *Funded by the Army in PE 0603734A.

(U) **Other Program Funding Summary Cost:** N/A

(U) **Schedule Profile:** N/A

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APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 2 Applied Research

R-1 ITEM NOMENCLATURE
Integrated Command and Control Technology,
PE 0602708E, R-1 #16

COST *(In Thousands)*	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
High Definition Systems IC-03	58,824	45,695	34,000	32,000	32,000	0	0	0	N/A

(U) **Mission Description:** This program element is budgeted in the Applied Research Budget Activity because it develops the technology and manufacturing capability for high definition displays and is important for virtually all DoD applications that involve visual and graphic information. Major components of this program include: projection, head mounted and direct view displays based on multiple technologies; development of equipment and components required to manufacture advanced display technologies; and prototype display systems for system evaluation. These efforts will establish a domestic technical capability for the manufacture of components necessary for military systems that capture, process, store, distribute and display high resolution images.

(U) **Program Accomplishments and Plans:**

(U) FY 1997 Accomplishments:

- Continued development of next generation reflective and emissive mobile display technologies and laser based projection systems for command and control applications. ($17.5M)
- Continued development of equipment and components to meet display cost and performance goals. This included efforts in field emission display materials, organic light emitting materials, reflective liquid crystal materials, phosphor technology development, and support for domestic display manufacturing infrastructure. ($28.2M)
- Continued development of system prototypes which leveraged earlier developed display technologies and incorporated integrated systems and intelligent interfaces. ($13.1M)

(U) FY 1998 Program:

- Continue development of large organic-based display technologies and systems for command and control applications, including laser based projection. ($9.3M)
- Continue development of equipment and components to meet display cost and performance goals. This will include efforts in printing and microreplication, field emission display materials, organic light emitting materials, phosphor technology development, and support for the domestic display manufacturing infrastructure. ($25.1M)
- Complete High Definition Optoelectric Digital Camera development. ($2.0M)
- Initiate Display Glass Manufacturing development. ($3.8M)

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RDT&E, Defensewide BA 2 Applied Research	Integrated Command and Control Technology, PE 0602708E, Project IC-03

(U) • Continue development of system prototypes which leverage earlier developed display technologies, particularly for mobile displays and incorporate integrated systems and intelligent interfaces. ($5.5M)

(U) FY 1999 Program:

 • Complete development of large organic-based display technologies and continue development of displays for command and control applications. ($10.0M)

 • Continue development of equipment and components to meet display cost and performance goals. This will include efforts in printing and microreplication, field emission display materials, organic light emitting materials, and phosphor technology development. ($12.0M)

 • Complete first generation integrated display systems and system prototypes for mobile applications. Continue development of large screen command and control system prototypes. ($12.0M)

(U) **Program Change Summary:**   *(In Millions)*   FY 1997   FY 1998   FY 1999

	FY 1997	FY 1998	FY 1999
President's Budget	59.7	37.0	40.0
Appropriated	59.7	47.2	N/A
Current Budget	58.8	45.7	34.0

(U) **Change Summary Explanation:**

FY 1997   Decrease reflects minor repricing.
FY 1998   Decrease reflects realignment of program priorities.
FY 1999   Decrease associated with re-emphasis of program on advanced technology research and a reduction in manufacturing infrastructure activities.

(U) **Other Program Funding Summary Cost:**   N/A

(U) **Schedule Profile:**   N/A

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COST (In Thousands)	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Materials and Electronics Technology	**203,887**	**231,353**	**244,408**	**234,218**	**250,208**	**264,706**	**266,640**	**Continuing**	**Continuing**
Materials Processing Technology MPT-01	110,200	122,081	145,381	141,950	139,327	142,527	146,227	Continuing	Continuing
Microelectronic Device Technologies MPT-02	56,530	74,520	87,910	80,722	90,881	97,179	90,413	Continuing	Continuing
Cryogenic Electronics MPT-06	16,650	18,404	8,203	11,546	20,000	25,000	30,000	Continuing	Continuing
Military Medical/Trauma Care Technology MPT-07	20,507	16,348	2,914	0	0	0	0	0	N/A

(U) **Mission Description:** This program element is budgeted in the Applied Research Budget Activity because its objective is to develop technology related to those materials, electronics, and medical devices that make possible a wide range of new military capabilities.

(U) The Materials Processing Technology project (MPT-01) concentrates on the development of novel materials, materials processing techniques, mathematical models and fabrication strategies for advanced structural and functional materials and components which will lower the cost, increase the performance, and enable new missions for military platforms and systems. Areas of concentration include exploitation of emerging processing approaches to tailor the properties and performance of structural materials and devices. This emphasis includes lightweight personnel protection, mesoscale machines for miniature devices, and ultra lightweight materials. The project also focuses on smart materials, sensors and actuators, functional materials and devices, advanced magnetic materials for non-volatile, radiation hardened magnetic memories, and electroactive polymers for sensing and actuating. Other areas of concentration include new materials concepts for portable power, protective coating materials to eliminate environmental hazards, infrared artificial dielectrics, development of bio-interface materials and methods, energy harvesting concepts, and frequency agile materials based on ferrite and ferroelectric oxides.

(U) The Microelectronics Device Technologies project (MPT-02) develops advanced electronic and optoelectronic devices, semiconductor process tools and methodologies, materials for optoelectronics and infrared devices. Areas of emphasis include high-performance analog-to-digital converters, military optical processors, novel integrated

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R-1 ITEM NOMENCLATURE
Materials and Electronics Technology,
PE 0602712E

optoelectronic devices and components, high temperature electronic devices, and high power electronics. This project includes a significant effort to develop advanced materials and device technology beyond the classical scaling limits of silicon device technology.

(U) In the Cryogenic Electronics project (MPT-06), thin film electromagnetic materials have reached a stage of development where specific applications can be identified in electronic devices and circuitry for military applications. Thin-film high temperature superconducting components packaged with cryogenic devices are being applied to radars, electronic warfare suites, and communications systems to enhance performance while reducing size and power requirements. Highly dependable and inexpensive cryocoolers (including thermoelectric coolers) are being developed for these applications, and expanded efforts will explore techniques to improve the performance of all solid state thermoelectric coolers as well as the overall cryogenic performance in applications ranging from communications to computing.

(U) The Military Medical/Trauma Care Technology project (MPT-07) is an initiative to significantly improve far-forward battlefield trauma care. The project focuses on the human factors of advanced technology concepts in a front-line battlefield environment through development of body-worn monitors, field-portable digital imaging equipment, battlefield surgical simulation and high-fidelity imaging for ultrasound.

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COST *(In Thousands)*	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Materials Processing Technology MPT-01	110,200	122,081	145,381	141,950	139,327	142,527	146,227	Continuing	Continuing

(U) **Mission Description:** The major goals of this project are to develop novel materials, materials processing techniques, mathematical models and fabrication strategies for advanced structural and functional materials and components which will lower the cost, increase the performance and/or enable new missions for military platforms and systems.

(U) One important area of concentration is the exploitation of emerging processing approaches to tailor the properties and performance of structural materials and devices. Thrusts in this area include new concepts for lightweight personnel protection, mesoscale machines for miniature devices, and ultra lightweight materials for lowering the weight and increasing the performance of aircraft and spacecraft structures. Smart materials, sensors and actuators for the control of the aerodynamic and hydrodynamic behavior of military systems are being developed and demonstrated to increase performance and lower detectability of aircraft, helicopters and submarines.

(U) A second major thrust is the development of functional materials and devices. This includes advanced magnetic materials for high sensitivity, magnetic field sensors; non-volatile, radiation hardened magnetic memories with very high density, short access time, infinite cycleability and low power; and electroactive polymers for sensing and actuating. Frequency-agile materials based on ferrite and ferroelectric oxides will be developed for tuned filters, oscillators and antennas. New permanent magnetic materials with significantly higher magnetic strength and higher operating temperature for motors, generators, flywheels, bearings, and actuators are also being explored. New materials and concepts for increasing the availability of portable power to the soldier are being investigated as are substitute protective coating materials which eliminate environmental hazards. Infrared Artificial Dielectrics (IRADs) are a new class of infrared materials having an emissivity that can be fully engineered for different spectral bands. For example, it may be possible for IRADs to camouflage hot objects from passive infrared sensors operating in the common 8-to-12 micron band.

(U) The unique characteristics of biologically derived functional materials and devices will be exploited through the understanding and control of the structure and chemistry of the interface between man-made and biotic materials. In addition, emulation and/or control of biological functionality (sensing, mobility, etc.) will be explored for enhanced DoD sensor, robotic, etc. applications.

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(U) **Program Accomplishments and Plans:**

(U) FY 1997 Accomplishments:

- Structural Materials and Devices. ($31.5M)
  - Demonstrated a 2X increase in mean-time-between-failures (MTBF) associated with the replacement of carbon engine starter oil face seals on aircraft with ceramic face seals.
  - Demonstrated novel, low cost processing approaches for ceramic composites for use in gas turbine engines.
  - Demonstrated production of titanium components using laser sintering techniques.
  - Demonstrated production of cast aluminum-beryllium components.
  - Demonstrated secondary processing of structurally porous ultra lightweight panels.
  - Demonstrated the capability to produce ceramic components with complex geometry and dimensional tolerances and mechanical properties comparable to mass manufactured advanced ceramics using Jet Printer technology (3-D printing).
  - Developed a new solid freeform build method for ceramic components based on layer-by-layer photolithography utilizing Digital Micromirror Display (DMD) electronically programmable photomasks.
  - Determined the feasibility of using new processing approaches (e.g., solid freeform fabrication) for controlling the dimensional tolerances, microstructural and mechanical properties, and affordability required for components and mesoscale machines.
  - Tested reconfigurable machines and tools in shop floor beta test sites.
  - Determined the performance characteristics of low cost, damage tolerant fibrous monolith components in engine environments.
  - Demonstrated control of physical vapor deposition metal-matrix processing and extended process control models to physical vapor deposition of metal coated fibers in 60 filament bundles.
  - Demonstrated initial fabrication of nanostructured, hard carbon coatings with high adhesion, low friction, high hardness and high wear resistance.
  - Determined the economic viability of Templated Grain Growth (TGG), a process by which solid phase epitaxy of crystallographically oriented seeds on near net shaped polycrystalline components is used for growth of single crystal-like oxides.

- Smart Materials and Devices. ($16.1M)
  - Demonstrated vibration reduction by a factor of ten in machine tools via specially designed sensor/actuator elements to enhance machining tolerances.
  - Constructed fully integrated hydro-acoustic noise suppression tile.
  - Conducted wind tunnel test of shape adaptive F-18 wing model.

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- Demonstrated vibration suppression in subscale helicopter blades in hover stand and wind tunnel tests.

- Functional Materials and Devices. ($44.0M)
  - Completed development of a plasma/ion etch numerical simulation.
  - Demonstrated predictive capability of high-pressure, low-order, chemical vapor deposition models and demonstrated feedback control to a desired wafer state.
  - Demonstrated intelligent processing of large area chemical vapor deposition (CVD) of diamond with production costs of $4/carat.
  - Demonstrated the advantages of thermal management diamond in the performance of a power amplifier for the Link-16 communication system.
  - Grew single crystal boules for two inch diameter silicon carbide semiconductor wafers by scaling up the reactor and developing larger seed crystals.
  - Demonstrated high temperature superconducting technology with greater than fifteen square inch format and greater than eighty percent yield.
  - Demonstrated large area deposition of giant magneto-resistive (GMR) materials.
  - Demonstrated prototype GMR magnetic memory cell and spin transistor memory cell using magnetic multilayers.
  - Began development of candidate polymers using advanced lithography techniques for infrared artificial dielectrics (IRADs).
  - Initiated effort on nanophase magnetic materials.
  - Achieved photodefinable dielectric for Seamless High Off-Chip Connectivity (SHOCC) interposer.

- Energy and Environmental Sciences. ($18.6M)
  - Demonstrated novel recycling/reclamation techniques for disposal of scrap polymer matrix composites.
  - Developed advanced erosion/corrosion resistant thin film coatings for military applications.
  - Demonstrated high yield, pilot scale production (1.5 megawatt/year) of high efficiency (10%) copper-indium diselenide (CIS) solar cells on flexible substrates.

(U) FY 1998 Program:

- Structural Materials and Devices. ($29.6M)
  - Demonstrate low cost titanium and superalloy component fabrication processes.
  - Demonstrate uniformly bonded face sheet attachment on ultra lightweight foamed metal structures.
  - Demonstrate a 5x reduction in prototyping time (print-to-part) for ceramic and metal gas turbine engine components utilizing solid freeform manufacturing.
  - Demonstrate laser workcell at a beta test site.

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APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 2 Applied Research	Materials and Electronics Technology, PE 0602712E, Project MPT-01

- Establish approaches for breakthrough gains in personnel protection performance (e.g., >100% from current capabilities for 7.62 mm armor piercing (AP) round) through the application of innovative materials, materials processing and phenomenological modeling of multicomponent materials systems.

- Build a high precision, silicon nitride roll gimbal and pitch shaft for an infrared (IR) seeker utilizing Shaped Deposition Manufacturing (SDM), which combines additive and subtractive processing.

- Select and begin a specific mesoscale machine demonstration of interest to DoD (e.g., miniature air pump, micro-cooler).

- Evaluate Al-Be F-15 rudder spar.

- Evaluate structurally porous ultra lightweight aircraft panels.

- Complete the fabrication and evaluation of nanostructured, hard carbon coatings with high adhesion, low friction, high hardness and high wear resistance.

- Smart Materials and Actuators. ($24.7M)

- Demonstrate a fabrication process for microintegrated smart materials.

- Demonstrate full size, smart material active helicopter blade structures and acoustic noise suppression structure on a rotor test stand.

- Evaluate actuation potential of magnetoelastic and magneto-shape memory transducer materials.

- Evaluate high performance electroceramic actuator fabrication processes.

- Demonstrate applicability of a smart shape adaptive wing to vortex destabilization concept in hydro applications.

- Design, build, test and evaluate high power laminated actuator stacks for smart defense structures utilizing Computer Aided Manufacturing-Laminated Engineering Materials (CAM-LEM) solid freeform fabrication (SFF) capability.

- Functional Materials and Devices.   ($46.6M)

- Demonstrate a prototype giant magneto-resistive (GMR) magnetic memory array and spin transistor memory cell array using magnetic multilayers.

- Develop microstructural models for prediction of GMR thin film properties.

- Design and build a very high sensitivity magnetometer.

- Continue polymer development using advanced lithography techniques for infrared artificial dielectrics (IRADs).

- Demonstrate electroactive optical flow characteristics of polymers.

- Initiate effort to reduce loss tangent in ferrites and ferroelectric oxides for frequency agile RF components.

- Demonstrate a switched circulator and phase shifter using thick film ferrites.

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	DATE February 1998

APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Materials and Electronics Technology, PE 0602712E, Project MPT-01

- Select model systems for establishing the structure, chemistry, and function of biotic/abiotic interfaces and biological systems which provide the capability to design biological and biohybrid devices of interest to DoD (e.g., sensors, smart membranes, actuators, etc.).

- Demonstrate proof of concept for templated vapor phase single crystal growth on projected x-ray interference patterns of atomic dimensions.

- Demonstrate high-density electronic interconnects for Seamless High Off-Chip Connectivity (SHOCC) interposer.

- Energy and Environmental Sciences. ($21.2M)

  - Demonstrate a hydrothermal oxidation pilot plant for the destruction of shipboard excess hazardous materials.

  - Demonstrate the utility of advanced erosion/corrosion resistant thin film coatings at a military site.

  - Demonstrate intelligent processing of thermal barrier coatings yielding reliable coatings which increase turbine engine inlet temperatures by up to 200 degrees F, with a commensurate increase of 10-15% in thrust.

  - Develop balance-of-plant and packaging for a direct oxidation fuel cell replacement for military standard batteries.

  - Demonstrate that full scale, intelligent processing of copper-indium diselenide (CIS) solar cells yields both performance and cost (<$1/watt) suitable for use of flexible photovoltaics in military operations.

  - Develop energy harvesting and storage concepts for unattended devices.

(U) FY 1999 Program:

- Structural Materials and Devices. ($33.1M)

  - Fabricate and test materials and materials systems concepts designed to significantly improve personnel protection performance (e.g., >100% from current capabilities for 7.62 mm armor piercing (AP) round), dramatically increasing protection for the individual soldier.

  - Demonstrate solid freeform fabrication of titanium forging blanks.

  - Demonstrate spray forming of superalloy forging billets.

  - Demonstrate the use of Solid Freeform Fabrication to upgrade distressed turbine vanes in man-rated gas turbine engines with ceramic composite components of high reliability.

  - Demonstrate initial feasibility and performance of a prototype mesoscale machine.

- Smart Materials and Actuators. ($26.5M)

  - Demonstrate vortex wake reduction for submarines using smart materials.

  - Demonstrate submarine acoustic noise reduction using smart material tiles.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

	DATE February 1998

APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 2 Applied Research	Materials and Electronics Technology, PE 0602712E, Project MPT-01

- Demonstrate a shape adaptive fighter inlet.
- Demonstrate fluid flow in an active submarine model.
- Establish growth conditions for piezoelectric single crystals from flux using both open and closed crucible techniques.
- Evaluate the impact of piezoelectric single crystals on Navy low-frequency surveillance sonar, mid-frequency navigation/tactical sonar, and high-frequency weapons guidance sonar.

• Functional Materials and Devices. ($60.6M)

- Demonstrate high speed, radiation hard, medium density, non-volatile magnetic memory utilizing magnetic multilayers; develop methods for controlling microstructure of giant magneto-resistive (GMR) films during growth.
- Demonstrate very high sensitivity magnetometer and gradiometer for localization of magnetic anomalies.
- Demonstrate permanent magnet material with 50 percent higher strength (Energy Product).
- Expand the Solid Freeform Fabrication program to demonstrate a new process for the fabrication of silicon carbide (SiC) devices using rapid tool-less vapor deposition processes.
- Complete polymer development for infrared artificial dielectrics (IRADs).
- Demonstrate a loss tangent less than 0.002 in hybrid ferrite/ferroelectric frequency agile filters.
- Demonstrate a voltage controlled oscillator (VCO) with an octave tuning range and low loss.
- Demonstrate scale-up capability for single crystal growth utilizing x-ray interference patterns to template crystal growth.
- Demonstrate enhanced biological responses (molecular, cellular and organismal) at modified material interfaces. Identify approaches for the neurological control and behavior of simple biological systems through biomaterial development.
- Demonstrate actuator materials and bioinspired control strategies for biomimetic locomotion systems; develop biomimetic systems that incorporate extremophile strategies for enhanced stability and performance in the environmental extremes required by DoD.
- Select available functional elements for preliminary experiments and establish system specifications for tropomorphic systems, i.e., systems which self-adaptively shed, heal, morph and grow to meet operational requirements.
- Demonstrate actuation capability of polymeric muscles.

• Energy and Environmental Sciences. ($25.2M)

- Demonstrate a low temperature, packaged direct oxidation fuel cell for soldier applications.
- Demonstrate alternative energy sources (including thermal energy conversion) for soldier microclimate cooling and for portable battery chargers.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

APPROPRIATION/BUDGET ACTIVITY	DATE February 1998
RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Materials and Electronics Technology, PE 0602712E, Project MPT-01

- Demonstrate energy harvesting from ambient sources for unattended sensor applications.
- Demonstrate approaches to augment portable power sources by recovering energy from human activity.
- Complete demonstration and insertion of advanced erosion/corrosion resistant thin film coatings in military systems.

(U) **Program Change Summary:** *(In Millions)*

	FY 1997	FY 1998	FY 1999
President's Budget	110.2	103.8	123.2
Appropriated	116.3	106.7	N/A
Current Budget	110.2	122.1	145.4

(U) **Change Summary Explanation:**

FY 1997   Decrease reflects minor program repricing, reprogramming of Small Business Innovative Research funding to PE 0605502E and reprogramming for the Hunter Unmanned Aerial Vehicle.

FY 1998-99 Increases reflect expansion of efforts in the Smart Materials and Functional Materials thrusts.

(U) **Other Program Funding Summary Cost:**   N/A

(U) **Schedule Profile:**   N/A

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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

	DATE	February 1998

APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Materials and Electronics Technology, PE 0602712E

COST (In Millions)	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Microelectronic Device Technologies MPT-02	56,530	74,520	87,910	80,722	90,881	97,179	90,413	Continuing	Continuing

(U) **Mission Description:** This project develops advanced electronic and optoelectronic devices, semiconductor process tools and methodologies, materials for optoelectronics, and infrared devices. Areas of emphasis include high performance analog-to-digital converters (ADCs), military optical processors, novel integrated optoelectronic devices and components, high temperature electronic devices and high power electronics. This microelectronics development project develops and demonstrates advanced microelectronics technology for DoD critical needs including digital radar receivers and acoustic-electronic components. Technologies developed in this project are performance driven and exceed commercial capabilities. This project includes a significant effort to develop advanced material and device technology beyond the classical scaling limits of silicon device technology.

(U) **Program Accomplishments and Plans:**

(U) FY 1997 Accomplishments:

* Completed hardware/software integration for advanced vision system, and demonstrated image recognition. ($8.2M)
* Demonstrated functionality and operation of high performance optoelectronic, digital processor prototype and developed advanced optoelectronic fabrication approaches and subassembly component technologies. ($18.4M)
* Developed component and fabrication technologies for radio frequency photonic components for application in millimeter wave and microwave transmission. ($2.4M)
* Initiated efforts to develop advanced digital-based radar receiver processor components based on high speed semiconductor technologies, such as heterojunction bipolar transistors (HBT). ($13.0M)
* Developed common complementary metal oxide semiconductor/silicon-on-insulator (CMOS/SOI) materials requirements to support low power electronics and radiation hardened performance requirements. ($2.7M)
* Advanced Microelectronics - Chose candidate multilayer semiconductor technologies; chose initial (150nm)[2] scale transistor configurations; and selected candidate high throughput 25 nm patterning technologies. ($9.8M)
* Initiated efforts to extend high performance mixed signal device technology to geometries below 0.18 micron. ($2.0M)

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DATE February 1998

APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 2 Applied Research

R-1 ITEM NOMENCLATURE
Materials and Electronics Technology,
PE 0602712E, Project MPT-02

(U) FY 1998 Program:

- Advanced Microelectronics - Choose candidate interconnect/stacking strategies. ($2.5M)
- Develop SiC materials for High Power Electronic Power Switching Devices in the 250° - 350°C range. ($2.0M)
- Evaluate thermal management strategies for megawatt-class power switch; evaluate approaches for controlling high-power switches with solid-state electronics (monolithic vs. hybrid); demonstrate 1000-V-class SiC switch. ($4.8M)
- Explore photonic approaches in the throughput of analog-to-digital converters. ($3.8M)
- Digital Receiver Processor - Continue efforts to develop advanced digital-based processor components based on high speed semiconductor technologies, such as heterojunction bipolar transistors. ($12.5M)
- Sonoelectronics - Initiate development of highly-effective sonoelectronic actuators and transducers that can be integrated directly with silicon Very Large Scale Integrated (VLSI) circuits. ($7.7M)
- VLSI Photonics - Demonstrate feasibility of integration of small arrays (4x4) vertical cavity surface emitting lasers with detectors, and identify degradation mechanism for polymer/small molecule lasers and demonstrate photopumped lasing. ($11.5M)
- Low Power Electronics - Develop circuits and circuits level design tools to reduce power dissipation for variety of circuits and assist in circuits level tradeoffs. ($1.0M)
- 3-D Microelectronics - Develop and demonstrate key technologies behind a packaging concept that uses a stacked MCM approach to reduce interconnect length and increase physical connectivity between layers of electronics. ($4.8M)
- Microelectronics Activity - Continue technology insertions at the Defense Microelectronics Activity. ($9.7M)
- Mixed-Mode Electronics - Initiate mixed-mode electronics multitechnology insertion (MIME). ($7.2M)
- Nanofabrication - Investigate areas of nanofabrication of electronic devices and extreme ultraviolet (EUV) lithography to be used in the next decade for the fabrication of semiconductor devices, such as nanoelectronics and micromechanical structures. ($6.0M)
- RF Photonics - Complete research in Radio Frequency Photonics. ($1.0M)

(U) FY 1999 Program:

- Advanced Microelectronics - Characterize candidate 25 nm transistors (150nm)^2 total area and establish process sequence for chip for proof of principle demonstration. ($10.1M)
- Digital Radar Receiver Processor - Develop advanced digital processor components. ($11.0M)
- Continue development of SiC materials for High Power Electronic Switching Devices. ($2.0M)

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APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide	Materials and Electronics Technology,
BA 2 Applied Research	PE 0602712E, Project MPT-02

- Demonstrate high-current-density (>100 A/cm^2) 1000-V-class SiC high power switch; demonstrate high-temperature (>250 C) operation of a 1000-V-class switch at high temperature. ($7.0M)
- VLSI Photonics - Demonstrate integrated 8x8 VLSI photonics chip (laser, detector and electronics) and optoelectronic modeling tools compatible with electronic CAD tools and demonstrate the feasibility of using molecular self-assembly techniques to position optoelectronic devices with high precision on silicon circuits. ($20.0M)
- Sonoelectronics - Incorporate transducers in new acoustic passive and active arrays, particularly acoustic imaging sensors, weapons, and catalytic drivers, and study the phenomenology associated with the interaction of these arrays with chemical and biological matter. ($16.0M)
- Begin development of integrated fluidic cooling systems having 1/100 the volume and mass of current state-of-the-art systems. ($4.8M)
- Initiate silicon RF high-fidelity electronics development for multifunctional sensor capacity. ($14.0M)
- Initiate fiber coupled IR sensor development for expanded sensor performance. ($3.0M)

(U) **Program Change Summary:**   (In Millions)   FY 1997   FY 1998   FY 1999

President's Budget   71.8   56.8   77.7

Appropriated   66.7   82.1   N/A

Current Budget   56.5   74.5   87.9

(U) **Change Summary Explanation:**

FY 1997 Decrease reflects rephasing of the A/D converter effort from FY 1997 to FY 1998 and SBIR transfer to PE 0605502E.

FY 1998 Decrease reflects rephasing of Advanced Microelectronics Devices efforts.

FY 1999 Increase reflects new initiatives in silicon RF, fiber coupled IR sensors, and integrated fluidic cooling development offset by reductions in manufacturing/integration technology efforts.

(U) **Other Program Funding Summary Cost:**   N/A

(U) **Schedule Profile:**   N/A

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APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 2 Applied Research

R-1 ITEM NOMENCLATURE
Materials and Electronics Technology,
PE 0602712E

COST (In Thousands)	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Cryogenic Electronics MPT-06	16,650	18,404	8,203	11,546	20,000	25,000	30,000	Continuing	Continuing

(U) **Mission Description:** Thin film electromagnetic materials have reached a stage of development where specific applications can be identified in electronic devices and circuitry for military systems. Films are deposited and patterned to form electromagnetic components in ways that are similar to, and compatible with, the processes of conventional semiconductor manufacturing. Such electromagnetic components, as well as complementary metal oxide semiconductors (CMOS), work best at lower temperatures, so that cryogenic packaging generally will be required for highest performance. Thin-film high temperature superconducting (HTS) components packaged with cryogenic devices are being applied to radars, electronic warfare suites, and communications systems to enhance performance by more than an order of magnitude while reducing size and power requirements. Particular demonstrations include an upgraded ship-defense radar (SPQ-9B) with 100X greater detectability of missiles in littoral clutter and communications receivers with greater immunity to interference. Highly dependable and inexpensive cryocoolers (including thermoelectric cryocoolers) are being developed for these applications and expanded efforts will explore techniques to improve the performance of solid-state thermoelectric coolers as well as the overall cryogenic performance in applications ranging from communications to computing.

(U) **Program Accomplishments and Plans:**

(U) FY 1997 Accomplishments:

- • Cryogenics Technologies. ($10.0M)
  - – Continued fabrication of cryo-radar, using HTS components and upgraded conventional components such as driver and active array, for final demonstration in FY 1998 with a simulated Naval scenario.
  - – Evaluated results of cryo-crossbar switch and asynchronous transfer mode (ATM) efforts. Determined most appropriate insertion for digital systems employing HTS devices as well as cryo-complementary metal oxide semiconductors (CMOS).
  - – Determined most important communications applications for cryo-components.
- • High Temperature Superconductivity. ($6.7M)
  - – Upgraded HTS switchable filter sets with tunable filters, for simpler construction and operation in aircraft Electronic Countermeasures (ECM) suites.
  - – Extended performance of "Manatee" signals intercept receiver to other frequency regimes, notably Global System for Mobile Communications (GSM).

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APPROPRIATION/BUDGET ACTIVITY	DATE	February 1998
RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Materials and Electronics Technology, PE 0602712E, Project MPT-06	

- Continued funding wire development efforts for magnet demonstrations, in application to mine detonation in littoral scenarios, and compact travelling-wave tubes (TWTs).
- Developed ultra-high Q thin-film filters for use in Single Channel Ground and Air Radio System (SINCGARS) and other communications sets.
- Evaluated advanced thermoelectric materials with significantly improved figure of merit including quantum well and multilayer structures.

(U) FY 1998 Program:

- Cryogenics Technologies. ($14.4M)
  - Demonstrate, at an appropriate facility, a fully functional Cryo-Radar, with 103 dB dynamic range, 15 dB greater than present performance, showing capability to detect targets over that range and an ability to address the defense of surface ships to attacking missiles.
  - Demonstrate, in flight test, a multi-band receiver capability in Joint Airborne SIGINT (Signals Intelligence) Avionics Family (JASAF) configuration.
  - Demonstrate capability for detection of low-level unintended radiation at ranges exceeding 50 km.
  - Demonstrate an improved analog to digital (A/D) converter employing cryogenic components.
  - Demonstrate a low-cost (less than $2500), highly reliable (greater than 30,000 hr) Sterling cycle cryocooler that delivers 5 watts at 80K with less than 200 watts of total power.
- Thermoelectric Materials and Devices. ($4.0M)
  - Demonstrate a thermoelectric cooler that will provide a reduction in temperature greater than 50°C in a single stage.

(U) FY 1999 Program:

- Cryogenics Technologies. ($3.2M)
  - Insert cryogenic packages in communication transceivers which mitigate electromagnetic interference effects.
- Thermoelectric Materials and Devices. ($5.0M)
  - Demonstrate thermoelectric coolers that can achieve 100°C cooling in less than three stages as compared to the current seven stages.
  - Demonstrate potential benefit of efficient power generation from thermoelectric devices operating at high temperature (>500°C).

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APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 2 Applied Research	Materials and Electronics Technology, PE 0602712E, Project MPT-06

(U) **Program Change Summary:** *(In Millions)*

	FY 1997	FY 1998	FY 1999
President's Budget	9.8	13.2	18.2
Appropriated	16.5	18.4	N/A
Current Budget	16.7	18.4	8.2

(U) **Change Summary Explanation:**

FY 1997 Increase reflects minor program repricing.
FY 1999 Decrease reflects reduction in the number and complexity of cryocooler and superconducting quantum devices demonstrations.

(U) **Other Program Funding Summary Cost:** N/A

(U) **Schedule Profile:** N/A

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APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 2 Applied Research

R-1 ITEM NOMENCLATURE
Materials and Electronics Technology,
PE 0602712E

COST (In Thousands)	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Military Medical/Trauma Care Technology MPT-07	20,507	16,348	2,914	0	0	0	0	0	N/A

(U) **Mission Description:** The objective of this project is to revolutionize far-forward battlefield trauma care. The project recognizes that planned downsizing of U.S. forces creates new pressures to ensure force readiness, skill mix, and effective joint doctrine at a time when battlefield casualties carry both strategic importance and tactical relevance. A review of combat casualty care has shown: (1) that 90% of combat deaths occur in the zone of close combat prior to medical or surgical intervention; (2) that 30-50% of these deaths are preventable with immediate, effective, correct medical treatment; (3) that casualty location is a continuing battlefield problem; and (4) that less than 5% of U.S. Army active-duty physicians have treated combat casualties.

(U)   The DARPA Combat Casualty Care program has two major segments: (1) Advanced Biomedical Technology (ABT) and (2) Ultrasonic Diagnostic Imaging. The ABT segment exploits DARPA's unique leadership role in the electronics and information sciences to project advanced medical and surgical care into the far-forward battlefield area to effect early, successful clinical intervention. This program is developing lightweight personnel status monitors (PSMs) permitting remote non-invasive clinical diagnosis (e.g., continuous monitoring of vital signs), casualty localization, and friend or foe identification. Additional sensor capabilities will be incorporated through a "smart tee-shirt," called the sensate liner, which is a fabric woven with fiberoptic, piezoelectric and other fibers with additional microsensors attached to the fabric to provide an entire suite of sensors for vital signs and physiologic monitoring. Wounded soldiers could be evacuated in a critical care life support for trauma and transport pod (LSTAT) which will function like an autonomous single-patient hospital intensive care unit.

(U)   The Ultrasonic Diagnostic Imaging segment will develop high-fidelity diagnostic imaging primarily for the far-forward battlefield environment. The emphasis of this effort is on enhancing and miniaturizing biomedical applications of ultrasound. For example, in conventional ultrasound imaging, the medium (i.e., human tissue) is inhomogeneous and scatters the signal, which blurs the image. The processes for developing high-resolution imaging will build upon the emerging technology of adaptive acoustics, the displays of which are intuitive and easily interpreted by the combat medic and physician.

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| RDT&E, Defensewide
BA 2 Applied Research | Materials and Electronics Technology,
PE 0602712E, Project MPT-07 |

(U)   In FY 1997, DARPA concluded funding efforts in advanced remote telesurgery and virtual reality for combat casualty care simulation. These areas are transitioning to the US Army Medical Research and Materiel Command (USAMRMC). Remote telesurgery technology could allow the projection of the expertise of a surgeon into the far-forward zone to surgically stabilize a badly wounded soldier. The advanced simulation technology efforts developed models, software, and hardware to improve the training of battlefield health care providers and to ensure skill currency. The objectives of these efforts were to provide for the virtual representation of human structure and function; ensure near-seamless transition from training to clinical practice; and to permit simulation of combat-casualty medical care within the framework of operational battlefield requirements.

(U)   This work does not duplicate any efforts of the Military Services or the National Institutes of Health. A Memorandum of Agreement exists between the Army Medical Department and DARPA.

(U)   **Program Accomplishments and Plans:**

(U)   FY 1997 Accomplishments:
  • Advanced Biomedical Technology. ($15.6M).
    - Developed and demonstrated respiration sensor for Personnel Status Monitor (PSM).
    - Developed first generation sensate liner for identifying penetrating wounds.
    - Incorporated full haptic interface (sense of touch) into limb trauma simulator, phase one of organ system surgical simulation, and integrated medic simulation into Dismounted Warrior Battle Labs (DWBL) and Special Operations Medical Training Center at Ft. Bragg, NC.
    - Developed interchangeable surgical tools for remote telepresence surgery and explored methodology for motion compensation (e.g., beating heart).
    - Installed one telesurgery system at the Uniformed Services University of Health Services (USUHS) for military physician training and evaluation.
    - Integrated micro-miniaturized components (ventilation, oxygen generator, monitors, power units) into beta version Life Support for Trauma and Transport (LSTAT) with canopy. Completed 3rd generation design of LSTAT which is NATO compatible.
  • 3-D Ultrasound Technologies. ($4.9M)
    - Continued to develop and implement the techniques of adaptive acoustics to ultrasonic imaging, utilizing 2-D sensor arrays and image processing.
    - Demonstrated battlefield tele-ultrasound unit in Bosnia, linking an Army field hospital in Bosnia with an Army hospital in Germany.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Materials and Electronics Technology, PE 0602712E, Project MPT-07

(U) FY 1998 Program:

- Advanced Biomedical Technology. ($9.3)
  - Complete sensor development for PSM system and transition to Army.
  - Complete microminiaturized oxygen saturation sensor.
  - Develop and integrate the sensate liner's suite of microsensors into the PSM system.
  - Develop virtual mock-up of next generation LSTAT and transition to Army.
- 3-D Ultrasound. ($7.0M)
  - Continue development, test and evaluation of 2-D array ultrasound transducer for portable applications.
  - Continue digital signal processing (DSP) for high-resolution, high signal-to-noise (S/N) ultrasound image.

(U) FY 1999 Program:

- 3-D Ultrasound Technologies. ($2.9M)
  - Complete ultrasound enhancements for scattering, deaberration, and beam forming and transition to Services.

(U) **Program Change Summary:** (In Millions)

	FY 1997	FY 1998	FY 1999
President's Budget	26.7	18.4	17.7
Appropriated	18.8	21.5	N/A
Current Budget	20.5	16.3	2.9

(U) **Change Summary Explanation:**

FY 1997   Increase reflects minor repricing of the Advanced Biomedical Technology program.

FY 1998-99 Decrease reflects transition of the Advanced Biomedical Technology program to eventual end users and completion of ultrasonic imager development efforts.

(U) **Other Program Funding Summary Cost:** N/A

(U) **Schedule Profile:** N/A

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R-1 ITEM NOMENCLATURE
Advanced Electronics Technologies,
PE 0603739E, R-1 #43

COST (In Thousands)	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Advanced Electronics Technologies	**342,243**	**281,909**	**244,737**	**259,014**	**212,385**	**233,340**	**241,279**	**Continuing**	**Continuing**
Uncooled Integrated Sensors MT-03	18,912	8,669	11,000	3,000	0	0	0	0	N/A
Electronic Module Technology MT-04	53,510	68,268	65,992	69,242	65,637	75,740	84,925	Continuing	Continuing
Tactical Information Systems MT-05	23,951	29,472	36,496	39,540	42,748	51,100	55,600	Continuing	Continuing
Microwave and Analog Front End Technology (MAFET) MT-06	38,015	18,250	4,000	0	0	0	0	0	N/A
Centers of Excellence MT-07	20,449	3,852	4,000	0	0	0	0	0	N/A
Manufacturing Technology Applications MT-08	31,447	29,162	25,200	21,951	0	0	0	0	N/A
Advanced Lithography MT-10	60,827	51,078	26,500	28,000	24,000	27,500	24,754	Continuing	Continuing
Electronic Commerce Resource Centers MT-11	34,288	0	0	0	0	0	0	0	N/A
Microelectromechanical Systems (MEMS) MT-12	60,844	73,158	71,549	72,281	50,000	49,000	41,000	Continuing	Continuing
Advanced Microsystems MT-13	0	0	0	25,000	30,000	30,000	35,000	Continuing	Continuing

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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE	DATE
RDT&E, Defensewide BA 3 Advanced Technology Development	Advanced Electronics Technologies, PE 0603739E	February 1998

(U) **Mission Description:** The Advanced Electronics Technology program element is budgeted in the Advanced Technology Development Budget Activity because it seeks to design and demonstrate state-of-the-art manufacturing and process technologies for the production of various electronics and microelectronic devices, sensor systems, actuators, and gear drives that have both commercial and military applications. Introduction of advanced product design capability and flexible, scalable manufacturing techniques will enable the commercial sector to rapidly and cost-effectively satisfy military requirements and enhance the U.S. industrial base.

(U) The Uncooled Integrated Sensors project addresses a long standing Defense requirement for uncooled, solid state advanced infrared sensor arrays for major weapons systems that do not require costly cryogenic cooling packages.

(U) The Electronic Module Technology project is a broad initiative to substantially decrease the cost and increase the performance of weapon systems through the timely insertion of state-of-the-art electronic modules. Electronic module technology addresses the design and fabrication of various types of digital, analog, and mixed signal modules consisting of electronic, electro-optical and micro-mechanical components. It includes traditional approaches such as printed circuit boards and emerging technologies such as high density Multichip Modules (MCMs).

(U) The Tactical Information Systems project contains three major programs: Head Mounted Displays (HMD), Smart Modules, and Warfighter Visualization. The Head Mounted Display program is developing world-class miniature displays and integrating these displays into head and helmet mounted configurations for use by pilots, combat vehicle crews and individual warriors, as well as for virtual environments and simulation. Smart Modules is a program to design and develop prototype modules, using core technologies that sense, think, and communicate, and integrate them into selected personal information products. Warfighter Visualization is a program to demonstrate the feasibility of combining real-time visual images of the environment with geospatially registered computer generated information for use by individual mounted and dismounted warfighters.

(U) The Microwave and Analog Front End Technology (MAFET) project has been the only DoD effort directed at significantly reducing non-recurring costs for military microwave/millimeter wave sensor systems through improved computer aided design capabilities. The MAFET program addresses the essential foundation for all DoD systems and programs making use of microwave and millimeter wave solid state technology.

(U) The Centers of Excellence project finances demonstration, training and deployment of advanced manufacturing technologies. The goal of this technology is to reduce unit and life-cycle costs while improving quality.

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PE 0603739E

(U)   The goal of the Manufacturing Technology Applications project is to reduce the cost and acquisition leadtime of future military systems by integrating manufacturing process considerations during the product design phase, and by demonstrating high efficiency multi-product prototype factories. This project will also enable manufacturers to economically produce military variants of their commercial products in limited quantities through the introduction of flexible process technologies.

(U)   Advanced Lithography technology has enabled the dramatic growth of integrated circuit capability. Advances have led directly to improvements in electronic and computing systems performance in terms of speed, power, weight and reliability.

(U)   The Microelectromechanical Systems (MEMS) project is a broad and cross-disciplinary initiative to develop an enabling technology that merges computation with sensing and actuation to realize new systems for both perceiving and controlling weapons systems, processes and battlefield environments. Using fabrication processes and materials similar to those that are used to make microelectronic devices, MEMS conveys the advantages of miniaturization, multiple components, and integrated microelectronics to the design and construction of integrated electromechanical systems. The microfluidic molecular systems program will address issues centered around the development of automated microsystems that integrate biochemical fluid handling capability along with electronics, opto-electronics and chip-based reaction and detection modules to perform tailored analysis sequences for monitoring of environmental conditions, health hazards, and physiological states.

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COST (In Thousands)	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
*Uncooled Integrated Sensors MT-03	18,912	8,669	11,000	3,000	0	0	0	0	N/A

*Formerly titled IR Focal Plane Array

(U) **Mission Description:** The Uncooled Integrated Sensors project addresses the technology necessary to produce affordable, infrared (IR) sensor arrays, essential to major weapon systems. The focal plane array consists of a two dimensional detector array sensitive in a broad spectral range, integrated with unique signal processing to enhance performance and provide more efficient utilization of the information. The critical elements of the technology addressed in this program include the infrared material, detector array fabrication, read-out electronics, cryogenic packaging and testing, and module assembly. Processing and fabrication techniques focus on the production of affordable arrays, at low volume, in the configurations required by weapon systems. Performance enhancements in uncooled infrared and near-infrared sensors are also being addressed to provide an integrated, broadband two dimensional sensor array without the cryogenic package usually associated with infrared sensors. Elimination of the cryogenic package dramatically reduces the cost of the sensor module, and provides a sensor package compatible with a wide range of system applications, including navigation, targeting and manportable systems. The solid state integrated sensor also solves the problem of blooming in the presence of high intensity sources, which is encountered with current low light level visible and near infrared sensors. Arrays will be built in the configuration required for missile seekers, target acquisition and navigational platforms, search and track, and threat warning systems.

(U) **Program Accomplishments and Plans:**

(U) FY 1997 Accomplishments:
- Completed single-wafer IRFPA processing on six inch silicon wafers. ($4.0M)
- Demonstrated capability to fabricate uncooled infrared sensor with one million pixels. ($5.0M)
- Assessed capability to fabricate thin film ferroelectric uncooled infrared sensor. ($3.2M)
- Evaluated imaging performance and anti-blooming of uncooled solid state sensor. ($6.7M)

(U) FY 1998 Program:
- Demonstrate uncooled infrared array with thermal sensitivity of 0.05 degrees. ($3.7M)
- Demonstrate low light level solid state imager with anti-blooming protection. ($5.0M)

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(U) **FY 1999 Program:**

- Fabricate and test integrated uncooled infrared array and solid state, low light level array with anti-blooming protection. ($7.0M).
- Establish feasibility of a solid state imager with spectral response beyond night vision goggles. ($4.0M)

(U) **Program Change Summary:** *(In Millions)*

	FY 1997	FY 1998	FY 1999
President's Budget	23.1	9.0	11.0
Appropriated	23.1	8.7	N/A
Current Budget	18.9	8.7	11.0

(U) **Change Summary Explanation:**

FY 1997 Decrease is a result of program repricing of single-wafer IRFPA processing effort and uncooled sensor evaluations and a reduction to finance a reprograming action for the Hunter Tier III.

(U) **Other Program Funding Summary Cost:** N/A

(U) **Schedule Profile:**

Plan   Milestones
Sep 98   Evaluation of large area uncooled sensor with less than 0.05 degree thermal sensitivity.
Jan 00   Evaluation of integrated sensor with broad band infrared response.

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COST (In Thousands)	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Electronic Module Technology MT-04	53,510	68,268	65,992	69,242	65,637	75,740	84,925	Continuing	Continuing

(U) **Mission Description:** The Electronic Module Technology Project is a broad initiative to substantially decrease the cost and increase the performance of weapon systems through the timely insertion of state-of-the-art electronic modules. Electronic module technology addresses the design and fabrication of various types of digital, analog, and mixed signal modules consisting of electronic, electro-optical and micro-mechanical components. It includes traditional approaches such as printed circuit boards and emerging technologies such as high density Multichip Modules (MCMs).

(U) The project has four major objectives: (1) shorten the overall design, manufacture, test, and insertion cycle for advanced electronic subsystems; (2) advance the state-of-the-art in electronic interconnection and physical packaging technology to allow circuits to operate close to their intrinsic maximum speed with less overhead in terms of volume, weight and cost; (3) provide a robust manufacturing infrastructure for electronic modules; and (4) demonstrate the system level payoff of electronic module technology through advanced technology demonstrations (ATDs).

(U) The project has the following major elements: Application Specific Electronic Modules (ASEM); Multichip Integration (MCI); Optical Micro-Networks (OMNET); Distributed Robotics; Design Support for mixed Technology Integration (Composite CAD) and the Molecular-Level Large-Area Printing (MLP) program. ASEM will reduce the non-recurring engineering time and cost for designing and inserting complex electronic modules. MCI will produce order of magnitude reductions in manufacturing costs and accelerate the acceptance and insertion of Multichip Integration technologies. OMNET seeks to demonstrate new paradigms for integrating electronic, electromechanical, and electro-optical components to enable small, lightweight, battlefield information systems. Distributed Robotics is a new effort to integrate developments in MEMS, power sources, communications, and advanced microelectronics to design, construct and field multiple, high-performance, mobile, autonomous systems. Composite CAD seeks to enable the design of systems incorporating emerging micro-devices and manufacturing processes by developing the design technology (tools, methodology, and architectures) to support device and systems design of mixed-technology integrated systems. The MLP program is exploring approaches to 'print' MEMS devices on large surfaces.

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(U) The major new effort planned for initiation in FY 1999 is the Photonic Analog to Digital Converters program. Photonic Analog to Digital Converters will combine the speed of photonics with DARPA-developed A to D converter technology.

(U) **Program Accomplishments and Plans:**

(U) FY 1997 Accomplishments:

- Completed and demonstrated final end-to-end Rapid Prototyping of Application-Specific Signal Processing (RASSP) signal processor design environment. Completed technology insertion demonstrations, benchmarking analysis, and technology transition activities. ($7.0M)

- Continued ASEM technology development and demonstrated new ASEM foundry capability for flexible production of modules with board-level integration. ($10.1M)

- Continued Multichip Integration program to demonstrate order of magnitude reductions in MCM manufacturing costs and MCM technology insertions. Continued insertion of MCM technology into dual-use products such as workstations, engine control and wireless communications. ($18.5M)

- Initiated OMNET program to demonstrate new paradigms for integrating electronic, electromechanical, and electro-optical components to enable small, lightweight, battlefield information systems. ($9.5M)

- Continued to refocus ASEM and MCM design technology to support the design of composite electronic systems from composable design tools (electronics composite CAD). Focused on multi-technology lumped behavior modeling capability. ($8.4M)

(U) FY 1998 Program:

- Complete ASEM program to reduce non-recurring engineering costs for designing and inserting multi-chip modules. ($6.3M)

- Complete the Multichip Integration (MCI) program to improve substrate fabrication, demonstrate reductions in Multichip Modules (MCM) manufacturing costs, and technology insertions. ($14.3M)

- Optical Micro-Networks (OMNET) - Downselect amongst heterogeneous integration technologies and demonstrate multi-functional integration of electronic, electro-mechanical and optoelectric components targeted to military information systems. ($12.7M)

- Distributed Robotics - Initiate effort to put together in one package low-weight (<2 kg), high-performance payloads including sensors, imagers, countermeasures, designators, communications, and munitions. ($8.8M)

- Composite CAD - Integrate a composable design capability for single chip electronics and MEMS systems. Develop models with parameters optimized for manufacturing variances. Initiate behavior modeling of mixed technology devices. ($17.5M)

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- Molecular-level, Large-area Printing (MLP) - Establish preliminary micro-molding process using commercially available (CD manufacturing) tool; initiate studies of alternative micro-printing processes (letterpress, gravure, tropomorphic). ($8.7M)

(U) FY 1999 Program:

- OMNET - Demonstrate integrated optoelectronic transceivers and optical switches for reconfigurable interconnections of sensors to processors and the ability to distribute computation across military platforms 1-100 meters in length for future Electronic Warfare/digital radar and image processors. ($10.0M)
- Distributed Robotics - Construct the unit platforms, integrate commercial or demonstrated technology elements (e.g., imagers, MEMS, wireless systems), and field packs/herds of units to demonstrate multiple, cooperative functions. ($13.0M)
- Composite CAD - Continue to develop the mixed domain (kinematic, electric, electrostatic, and fluidic) analysis of micro-machined devices, systems of devices and corresponding electronic circuits to support the design of composite electronic sensors and systems. ($22.0M)
- Photonic A/D - Initiate photonic A/D converter development to achieve breakthrough in high speed A/D conversion. ($9.0M)
- MLP - Complete experimental characterization of release agents for micromolding; select candidate printing processes (≤2) and compatible readout process for development; and demonstrate writing on non-flat surfaces with radii of curvature in the range 1m to 1cm. ($12.0M)

(U) **Program Change Summary:** (In Millions)

	FY 1997	FY 1998	FY 1999
President's Budget	59.7	64.7	94.1
Appropriated	63.5	62.5	N/A
Current Budget	53.5	68.3	66.0

(U) **Change Summary Explanation:**

FY 1997 Decrease reflects drawdown of the ASEM and MCI programs as these programs neared completion and reprogramming to SBIR program.

FY 1998 Increase reflects repricing of the final increment of the ASEM program, Robotics and Composite CAD efforts.

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FY 1999 Decrease reflects deferral of digital radio and navigation chip new starts, offset by initiations of the Photonics A-D converter effort.

(U) **Other Program Funding Summary Cost:** N/A

(U) **Schedule Profile:**

Plan	Milestones
Jun 98	Demonstrate efficient 3-D electromagnetic modeling capability.
Aug 98	Complete testing of integrated optoelectronic devices.
Sep 98	Demonstrate MCM substrates with integrated passive components.
Jul 99	Demonstrate mixed energy domain analysis capability for integrated technology devices.
Aug 99	Demonstrate optical micronetwork with reconfiguration capability.
Nov 99	Initial prototype of tightly integrated adaptive payload technology.

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COST *(In Thousands)*	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Tactical Information Systems MT-05	23,951	29,472	36,496	39,540	42,748	51,100	55,600	Continuing	Continuing

(U) **Mission Description:** This project is a major DoD effort to develop the technology for displays and portable information systems for use in a variety of military systems. The project has three major efforts: Head Mounted Displays (HMDs), Smart Modules, and Warfighter Visualization. The Head Mounted Displays program develops world-class miniature displays and integrates these displays into head and helmet mounted configurations for use by pilots, combat vehicle crews and individual warriors as well as for virtual environments and simulation. Smart Modules will design, develop, and integrate prototype modules, using core technologies that sense, think, and communicate into selected personal information products. Warfighter Visualization efforts demonstrate the feasibility of combining real-time visual images of the environment with geospatially registered computer generated information for use by individual mounted and dismounted warfighters.

(U) **Program Accomplishments and Plans:**

(U) FY 1997 Accomplishments:

- Demonstrated feasibility of diffraction grating and MEMS based miniature displays. This type of display will greatly reduce the head-borne weight to a few ounces and significantly reduce power consumption over currently available displays. ($5.3M)
- Demonstrated the feasibility of combining computation, wireless communicating capability, and high resolution display in a paper sized device operating on commercially available batteries. Demonstrated electronic information capability integrated into soldier's clothing. ($14.8M)
- Developed several technology efforts that will allow tracking of hand and head motion for mobile, untethered individuals. ($3.9M)

(U) FY 1998 Program:

- Demonstrate prototype electric countermeasures system integrated into a solider worn vest. The computational capability developed in the FY 1997 program will be augmented with two PC cards containing ECM circuitry and will allow dismounted soldiers to instantly locate radio emissions from hostile forces. Demonstrate a prototype water proof computer for underwater use in SEAL and Explosive Ordnance Disposal applications. ($15.4M)
- Continue efforts to develop hand and head motion tracking technologies. Tracking head movement will allow a computer to display information to a head mounted display that is registered in the geospatial direction

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that the individual is looking. Tracking hand motion will allow a computer to recognize pointing and gestures as input mechanisms instead of using a keyboard. ($6.4M)

- Demonstrate image capture and geospatial registration of icons on terrain in a moving vehicle. The vehicle will be equipped with video cameras that provide a 360 degree view. Inside the vehicle, a person wearing a head tracked, head mounted display will be able to look around and view the images obtained from the cameras. Icons and graphical images generated by a computer will be overlayed on the camera image in the head mounted display. These images will be registered with the viewed real-world terrain. ($7.7M)

(U) FY 1999 Program:

- Demonstrate a novel capture device that incorporates signal and data processing in a 3-D package for use by individual soldiers. This miniature device weighing only a few ounces will be able to capture an image and rapidly analyze movement or correlate images with all processing done on the focal plane. The camera will be able to be worn by individual soldiers and communicate via a radio to and from geographic information system data bases. ($9.2M)

- Demonstrate a wearable computer incorporating wireless communication in a one pound, one watt configuration. This represents a 3x improvement in weight and a 10x improvement in power over current technology. The wearable computer will be used in a wide variety of applications by the small unit operations soldier. ($9.9M)

- Demonstrate prototype capability for dismounted soldiers to view the real world with overlayed graphic symbology. This capability will allow the soldier to receive visual information that is relevant to his/her mission time or location. It will also allow the soldier to interrogate databases containing information about the specific objects in his/her viewing environment. ($5.8M)

- Demonstrate prototype "see-through" tank concept. This capability will allow a "buttoned-up" tank crew wearing head mounted displays to view the outside world as though the tank were made of glass. This will be accomplished by placing cameras on the outside of the tank that provide inputs to a mapped memory. Images will be fed to the users' head mounted display depending upon the direction that the user is looking. This capability will significantly enhance the situation awareness of the tank crew. ($6.5M)

- Demonstrate a capability to obtain one-dimensional and two-dimensional data from a submarine sensor suite and configure these data into a 3-dimensional image covering 360 degrees that is provided to a head tracked, head mounted display. This capability will be used by a submarine conning officer to demonstrate an enhanced capability for under ice submarine navigation. ($5.1M)

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(U) **Program Change Summary:** (In Millions)

	FY 1997	FY 1998	FY 1999
President's Budget	24.4	34.9	35.6
Appropriated Budget	18.4	33.6	N/A
Current Budget	24.0	29.5	36.5

(U) **Change Summary Explanation:**

FY 1997 & 99   Changes reflect reprioritization of internal programs to allow for additional efforts in the head and hand motion tracking arena.

FY 1998   Decrease reflects deferral of boot-mounted navigation device initiative.

(U) **Other Program Funding Summary Cost:**   N/A

(U) **Schedule Profile:**

Plan	Milestones
Feb 98	Prototype head and hand tracking demonstration.
Feb 98	Demonstrate low power display for future head mounted displays.
Mar 98	Demonstrate air combat, air controller modules.
Apr 98	Demonstrate prototype see-through vehicle concept.
Dec 98	Demonstrate image capture sensor using 3-D packaging.
Feb 99	Demonstrate 1 pound, 1 watt wearable computer system.
Feb 99	Real world viewing with computer generated graphic overlay demonstration.
Jul 99	Demonstrate see-through tank.
Dec 99	Build and test Advanced Humanistic Platform prototype.
Dec 99	Develop hybrid sensor tracking features and including "smart camera" functions to allow collaborative updates between soldiers.
Jul 00	Develop real-time visual data correlation system in dismounted and mounted warrior applications.
Jul 00	Demonstrate dynamic multi-sensor I/O in both dismounted and mounted military applications.

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COST *(In Thousands)*	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Microwave and Analog Front End Technology MT-06	38,015	18,250	4,000	0	0	0	0	0	N/A

(U) **Mission Description:** Microwave and millimeter wave technology for DoD electronic weapon systems is at a critical crossroads. Great progress has been made under the microwave and millimeter wave integrated circuit (MIMIC) program in terms of maturing the gallium arsenide industrial community. The DoD is now far ahead of the commercial world in microwave and millimeter wave technology in terms of performance characteristics. However, in many cases, radio frequency (RF) sub-system costs are still a major impediment to fielding DoD weapon systems. Material, processes and design technology advances must be undertaken to sustain an effective defense capability and to maintain U.S. dominance in this critical technology area. The Microwave and Analog Front End Technology (MAFET) program is the only DoD effort directed at significantly reducing non-recurring costs for military microwave/millimeter wave sensor systems through improved computer aided design capabilities and advanced technologies. It will provide urgently needed improvements in the performance and affordability of microwave and millimeter wave components. The MAFET program addresses the essential foundation for all DoD systems and programs making use of microwave and millimeter wave solid state technology.

(U) Specifically, the MAFET program will provide the DoD with the state-of-the-art electronic systems that it needs to maintain its force multiplying capability. The program will: (1) reduce design time and cost for every RF system being developed or upgraded through an improved microwave/millimeter wave design environment; (2) break the very expensive cycle and time-consuming current practice of design-build-test--redesign-rebuild-retest; (3) put in place repeatable, robust processes to produce high frequency components; (4) make strategic investments in critical passive, packaging and integrated circuits devices needed for millimeter wave systems; and (5) investigate revolutionary solutions to the long-standing problem of insufficient power in solid-state radar and communications transmitters.

(U) **Program Accomplishments and Plans:**

(U) FY 1997 Accomplishments:

• Continued microwave/millimeter wave computer aided design environment development with implementation of advanced microwave/millimeter wave CAD tools and integrated tool sets and implementation of improved models. Conducted assessment and demonstration of design environment effectiveness through quantitative assessment of benchmarking metrics. Continued development and implementation of MHDL. ($10.0M)

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- Completed advanced sensor technology developments in the area of millimeter wave test. In addition, demonstrated: (1) millimeter wave InP high electron mobility transistor (HEMT) monolithic microwave integrated circuits (MMICs) with high yield; (2) low cost, high Indium-content field effect transistor (FET) materials on gallium arsenide; (3) microwave and millimeter wave device arrays; (4) advanced mixed signal chips for highly integrated frequency synthesizers; (5) low cost MMIC components for electronic warfare transmitter arrays; (6) miniaturized microwave and millimeter wave ferrite circulators; (7) automated millimeter wave load pull test station; and (8) on-wafer known good die test station. Continued development of remaining advanced sensor technology with demonstrations of improved performance coupled with cost savings. ($17.4M)

- Began development of all-solid-state X-band source with high output power and low fabrication cost. ($4.0M)
- Began development of all-solid-state quasioptical Ka-band source with high output power. ($3.0M)
- Demonstrated MEMS X-band phase shifter technology at high power and ultra low loss. ($1.0M)
- Began development of MEMS controlled beam-steering module at mm-wave frequencies. ($.8M)
- Began development of high-power (10W) W-band solid-state MMICs. ($1.8M)

(U) FY 1998 Program:

- Complete microwave/millimeter wave computer aided design environment. Demonstrate design environment effectiveness. Continue implementation of Microwave Hardware Description Language (MHDL). ($6.8M)
- Complete advanced sensor technology developments in the areas of: advanced fabrication, packaging, and multichip assembly (MCA) foundries. In the fabrication area, demonstrate: (1) production InP HEMT and HBT millimeter wave processes; (2) advanced manufacturing processes for: high power and high efficiency, and high dynamic range, capability; and (3) highly manufacturable and reliable HBT high power amplifiers. In the packaging area, demonstrate: (1) a 10x cost reduction in plastic HDI module fabrication technology; and (2) a 7x RF interconnect/package reduction due to embedded transmission lines and advanced multilayer interconnect. In the foundry area, demonstrate a 5x reduction in MCA production cost. ($5.2M)

- (1) In novel high-power transistor area, demonstrate 5-W SiGe HBT solid-state power amplifier (SSPA) having near-50% power-added efficiency (PAE) at X-band; demonstrate 10-W GaN MODFET having PAE=50% in X band; demonstrate 25-W SiC MESFET having PAE=45% in X band. (2) In quasioptics area, continue development of solid-state quasioptical Ka-band sources with high output power and high coherence; complete and demonstrate numerical design tool. (3) In MEMS-switch area, demonstrate 4-bit true-time-delay phase shifter in (a) X-Band with 2-dB total loss, and (b) Ka-Band with 3-dB loss; demonstrate 20/44-GHz dual-frequency MEMS-switched planar antenna. (4) In micromachined circuits and novel thermal management area, demonstrate

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micromachined W-band Wilkinson combiners in Si substrates; demonstrate Flourinert cooling of a 10-W X-band MMIC and a 1-W Ka-band MMIC. ($6.2M)

(U) FY 1999 Program:

* In quasioptics area, demonstrate a set of quasioptical grid-, array-, card-, and slab-combined power amplifiers including (a) a 100-W 50%-PAE card amplifier at 10 GHz, (b) a 20-W-output >25%-PAE array amplifier at 35 GHz, (c) a 20-W-output 15-to-20%-PAE grid amplifier at 40 GHz, (d) a 10x10-element 10-W electronically-steerable array amplifier at 44 GHz, and (e) a 5-W 20%-PAE slab-amplifier at 94 GHz. ($2.0M)

* In MEMS-switch area, demonstrate MEMS-tunable Chebyshev filter operating at 20 and 45 GHz; demonstrate MEMS-array transmitting beam-steerer at 44 GHz. ($1.0M)

* In micromachined circuits and novel thermal management area, demonstrate a micromachined SSPA ("W-Band Power Cube") having 2 W/in² intensity radiated from top facet. The power cube will be fabricated with InP Power MMICs that are thermally managed by bump bonding and are coupled to free space by Si-micromachined feed-line and planar-antenna structures. ($1.0M)

(U) **Program Change Summary:** (In Millions)

	FY 1997	FY 1998	FY 1999
President's Budget	41.2	28.0	13.2
Appropriated	45.9	23.2	N/A
Current Budget	38.0	18.2	4.0

(U) **Change Summary Explanation:**

FY 1997   Decrease reflects both the Hunter Tier 3 reprogramming action and reprograming to SBIR program.
FY 1998-99 Decrease reflects accelerated program phase down; anticipated completion by the end of FY 1999.

(U) **Other Program Funding Summary Cost:**   N/A

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(U) **Schedule Profile:**

Plan	Milestones
Mar 98	Demonstrate 20-W X-band all-solid-state sources.
Jun 98	Demonstrate embedded transmission line MMICs.
Sep 98	Ultra-low-cost SiGe T/R modules.
Dec 98	Demonstrate 10-W millimeter wave power amplifier array.
Jan 99	Demonstrate millimeter wave micromachined solid-state power amplifier.
Mar 99	Demonstrate millimeter wave beam steering module.
Jun 99	Demonstrate > 100-W low cost X-band electronically steerable source.
Sep 99	Demonstrate full interoperability of CAD vendors.

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COST *(In Thousands)*	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Centers of Excellence MT-07	20,449	3,852	4,000	0	0	0	0	0.	N/A

(U)   **Mission Description:** This project provides funding for Centers of Excellence at the Robert C. Byrd Institute for Advanced Flexible Manufacturing at Marshall University, and the Focus: HOPE National Center for Advanced Technologies (NCAT). The purpose of these Centers is to demonstrate, deploy and provide advanced manufacturing technology to significantly reduce unit production and life cycle costs, improve product quality, and deploy manufacturing training systems.

(U)   The Institute for Advanced Flexible Manufacturing provides both a teaching factory and initiatives to local area industries to utilize computer-integrated manufacturing technologies and managerial techniques to improve productivity and competitiveness. The National Center for Advanced Technology (NCAT) is a component of the Focus: HOPE Project whose purpose is to train technicians/engineers in advanced manufacturing processes and methods, demonstrate state-of-the-art flexible manufacturing and serve as a testbed for emerging manufacturing research.

(U)   This project also included funding in FY 1997 for the U.S.-Japan Management Training Program whose purpose was to build a growing infrastructure of American scientists and engineers with knowledge about the Japanese R&D enterprise and provide training in the Japanese language.

(U)   **Program Accomplishments and Plans:**

(U)   FY 1997 Accomplishments:
- Focus: HOPE. ($9.5M)
  - Successfully demonstrated the integration of computer models with numerically controlled machine tools.
  - Developed a digital library and demonstrated its use in enhancing the education and training of machinists.
- Institute for Advanced Flexible Manufacturing. ($4.0M)
  - Developed technical programs and training efforts to encourage local businesses to adapt flexible manufacturing techniques. Established satellite sites to ensure broader technology deployment.
- U.S.-Japan Management Training. ($7.0M)
  - Continued efforts with centers of excellence to facilitate students', researchers', and executives' understanding of Japan's manufacturing infrastructure, culture and language.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

DATE	February 1998

APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Advanced Electronic Technologies, PE 0603739E, Project MT-07

(U) **FY 1998 Program:**
- Institute for Advanced Flexible Manufacturing. ($3.9M)
  - Complete development of internetting capabilities to ensure medium- and small-sized businesses have access to emerging electronic commerce and advanced technologies.

(U) **FY 1999 Program:**
- Institute for Advanced Flexible Manufacturing. ($4.0M)
  - Complete assessment of Institute's performance and begin plans to transition from DoD to state/private support.

(U) **Program Change Summary:** *(In Millions)*

	FY 1997	FY 1998	FY 1999
President's Budget	14.0	4.0	0
Appropriated	20.5	3.9	N/A
Current Budget	20.5	3.9	4.0

(U) **Change Summary Explanation:**

FY 1999 Increase to ensure successful transition of the IAFM from DoD to state/private support.

(U) **Other Program Funding Summary Cost:** N/A

(U) **Schedule Profile:**

Plan
Milestones
Oct 98 Demonstrate advanced internetting capabilities that can be utilized by medium- and small-sized businesses to access emerging electronic commerce and advanced technologies.
Oct 99 Complete assessment and plan transition of Institute from DoD to state/private support.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

	DATE	February 1998

APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Advanced Electronics Technologies, PE 0603739E

COST *(In Thousands)*	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Manufacturing Technology Applications MT-08	31,447	29,162	25,200	21,951	0	0	0	0	N/A

(U) **Mission Description:** Future military systems will be affordable only if the manufacturing process is considered as an integral part of product design, production takes place in flexible, multi-product factories, and if advanced manufacturing technology is combined effectively with advanced business practices. This program focuses on demonstrations of process technology combined with innovative industrial practices and will measure the improvements in cost, schedule and quality achievable in key defense product areas. Two major initiatives are included in the FY 1997-2000 program: Affordable Multi-Missile Manufacturing (AM3) and the DARPA/Tri-Service Flexible Interferometric Fiber Optic Gyroscope (IFOG) Manufacturability Program.

(U) The Affordable Multi-Missile Manufacturing (AM3) program is an Advanced Technology Demonstration initiated in FY 1995. The objective of AM3 is to demonstrate the feasibility of 25-50% reductions in the unit cost of tactical missiles, both in ongoing missile production programs and in new missiles and major modifications. This will be accomplished by teams of missile prime contractors, component suppliers and manufacturing equipment and software vendors who develop and demonstrate the combined effects of advanced design, manufacturing, assembly systems and processes, missile value engineering changes, and acquisition reform and business practice innovations. A major technical theme is to achieve economies across a mix of missiles to compensate for the decline in individual missile quantities. Demonstrations will be conducted in the design and manufacture of components and guidance and control/seeker assemblies for multiple missiles, including R&D and production programs.

(U) Interferometric Fiber Optic Gyroscopes (IFOG) are emerging as preferred technology for future military and commercial inertial navigation applications. The emphasis of the IFOG Manufacturability Program is on achieving the design and manufacturing flexibility required to make low volume Defense components economically viable when compared to high volume commercial production. This program will develop the large throughput robotic assembly, packaging and testing technologies necessary to fabricate navigation-grade (0.01 deg/hr) Interferometric Fiber Optic Gyroscopes (IFOGs) at less than $1,500 per axis as a goal. This will enable affordable, accurate (1nmi/hr) inertial navigators for use during extended periods of Global Positioning System (GPS) signal outage due to enemy jamming or signal obscuration. Flexible manufacturing enables, from the same production line, fabrication of navigation grade, military tactical grade (0.1 - 1.0 deg/hr) IFOGs and lower performing (> 1 deg/hr) commercial IFOGs.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE	DATE February 1998
RDT&E, Defensewide BA 3 Advanced Technology Development	Advanced Electronics Technologies, PE 0603739E, Project MT-08	

(U) **Program Accomplishments and Plans:**

(U) FY 1997 Accomplishments:

- Affordable Multi-Missile Manufacturing (AM3). ($11.6M)
  - Completed AM3 Phase 2 component-level validation demonstrations.
  - Competitively selected two pilot enterprises for AM3 Phase 3, and initiated cost-shared implementation and demonstration of concepts and technology across the target missile mix.
  - Initiated first demonstrations of supply chain technologies to fill gaps identified in AM3 Phase 1 and continued technical integration and independent cost analysis.

- Interferometric Fiber Optic Gyroscope (IFOG). ($19.8M)
  - Evaluated wound coils and packaged subassemblies for IFOGs.
  - Continued to implement brassboard IFOG unit manufacturing processes.
  - Delivered superluminescent optical sources.

(U) FY 1998 Program:

- Affordable Multi-Missile Manufacturing. ($24.3M)
  - Continue AM3 Phase 3 implementation of new factory systems and new business practices in at least two pilot enterprises.
  - Complete initial design and test planning for AM3 multi-missile components and value engineering change proposals.
  - Complete initial demonstrations of supply chain technologies to fill gaps identified in AM3 Phase 1, and continue technical integration and independent cost analysis.

- Interferometric Fiber Optic Gyroscope (IFOG). ($4.9M)
  - Demonstrate flexible production of navigation grade and tactical grade IFOG units.
  - Demonstrate production of high power, stable, packaged optical sources, low cost couplers and wavelength division multiplexers.

(U) FY 1999 Program:

- Affordable Multi-Missile Manufacturing. ($25.2M)
  - Continue AM3 Phase 3 implementation of flexible multi-product assembly cells and prototype production of missile hardware.
  - Conduct initial tests of missile seekers built with the Affordable Multi-Missile Manufacturing (AM3) scalable family of parts and commercial components.

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	DATE February 1998

APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Advanced Electronics Technologies, PE 0603739E, Project MT-08

(U) **Program Change Summary:**   *(In Millions)*

	FY 1997	FY 1998	FY 1999
President's Budget	34.1	32.4	25.2
Appropriated	32.5	31.2	N/A
Current Budget	31.4	29.2	25.2

(U) **Change Summary Explanation:**

FY 1997-98 Decreases reflect program repricing and reprogramming to SBIR program.

(U) **Other Program Funding Summary Cost:**   N/A

(U) **Schedule Profile:**

Plan   Milestones

Mar 98   Define AM3 common focal plane array architecture.

Apr 98   Demonstrate assembly of brassboard IFOG units.

May 98   Demonstrated production of novel wavelength stabilized Interferometric Fiber Optic Gyroscope (IFOG)
         light source.

Jul 98   Define AM3 common inertial measurement unit baseline architecture.

Dec 99   Complete AM3 Phase 3 multi-missile manufacturing demonstrations.

Jun 00   Complete flight tests of AM3 missile seeker prototypes.

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DATE   February 1998

APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 3 Advanced Technology Development

R-1 ITEM NOMENCLATURE
Advanced Electronics Technologies,
PE 0603739E

COST (In Thousands)	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Advanced Lithography MT-10	60,827	51,078	26,500	28,000	24,000	27,500	24,754	Continuing	Continuing

(U) **Mission Description:** Lithography technology has enabled the dramatic growth in microelectronics capability over the past three decades and microelectronics is a key to improved weapon system performance. The improved capabilities in semiconductor technology contribute to significant system gains in speed, reliability, cost, power consumption, and weight. Advanced microelectronics technology is essential for computing and signal processing throughout essentially all military systems including command, control, communications, and intelligence; electronic warfare; and beam forming for radar and sonar. Further improvements in areas such as target recognition, autonomous guided missiles, and digital battlefield applications require microcircuits with smaller features to meet the operational speed, power, weight and volume constraints of these systems.

(U) Current microelectronics fabrication utilizes feature sizes of 0.35 microns. The Advanced Lithography Program emphasizes longer term research with expected high payoff in the fabrication of semiconductor devices with 0.1 or less micron feature sizes. These programs will develop technology for sub 0.1 micron features. Current programs in cross-cutting technologies (mask, stages, resists, metrology) and x-ray lithography will be completed in one - two years. Key subsystems of the maskless e-beam developments will be demonstrated late in the decade.

(U) **Program Accomplishments and Plans:**

(U) FY 1997 Accomplishments:

- Demonstrated full-chip stitching for e-beam projection (SCALPEL) and initiate maskless lithography efforts. ($10.0M)

- Installed process for using tantalum absorber on SiC membrane for x-ray mask and demonstrate solid-state power supply for dense plasma focus source. ($11.7M)

- Demonstrated 25 wafers per hour throughput for synchrotron stepper and demonstrate gas-field ion source test column for mask repair. ($10.1M)

- Initiated development of a prototype point x-ray source suitable for integration into a tool capable of meeting manufacturing for design rules of 0.13 microns and below. ($3.0M)

- Continued effort to develop a point source x-ray lithography system focusing on a dense plasma focus source and a stepper/aligner system. ($11.0M)

- Continued development of the Lithographic and Alternative Semiconductor Processing Techniques (LAST) Center to develop mask technology for semiconductor device fabrication. ($15.0M)

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APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 3 Advanced Technology Development	Advanced Electronics Technologies, PE 0603739E, Project MT-10

(U) **FY 1998 Program:**

- Research efforts for sub 0.1 micron in maskless lithography (emitter arrays and photocathodes), innovative imaging materials, and network of university efforts in novel patterning. ($19.9M)
- Complete development on cross-cutting technology in precision stages and mask making (e-beam writing and inspection) for 0.13 - 0.10 micron features. ($6.2M)
- Complete point-source x-ray lithography program. ($2.9M)
- Continue development of the Lithographic and Alternative Semiconductor Processing Techniques (LAST) Center to develop mask technology for semiconductor device fabrication. ($17.3M)
- Continue Laser Plasma x-ray source technology. ($4.8M)

(U) **FY 1999 Program:**

- Continue efforts in maskless lithography, including arrays of miniature e-beam columns, and novel imaging materials and pattern transfer processes.
  - Continue network of university efforts in novel patterning. ($9.5M)
  - Complete column test stand for maskless e-beam writer. ($17.0M)

(U) **Program Change Summary:** *(In Millions)*

	FY 1997	FY 1998	FY 1999
President's Budget	62.7	32.0	32.0
Appropriated	62.7	51.1	N/A
Current Budget	60.8	51.1	26.5

(U) **Change Summary Explanation:**

FY 1997 Decrease reflects minor program repricing and reprogramming to SBIR program.
FY 1999 Decrease reflects realignment of program priorities.

(U) **Other Program Funding Summary Cost:**   N/A

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Advanced Electronics Technologies, PE 0603739E, Project MT-10

(U) **Schedule Profile:**

Plan   Milestones

Jun 98   Demonstrate maskless printing of contact level using laser interferometric lithography.

Jun 99   Demonstrate switched emitter arrays for maskless lithography.

Mar 01   System demonstration of maskless charged particle writer.

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APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 3 Advanced Technology Development

R-1 ITEM NOMENCLATURE
Advanced Electronics Technologies,
PE 0603739E

COST (In Thousands)	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Electronic Commerce Resource Centers MT-11	34,288	0	0	0	0	0	0	0	N/A

(U) **Mission Description:** The mission of this program is the transfer of electronic commerce (EC) technologies to small- and medium-size enterprises (SMEs) through a network of regional deployment centers. This mission is a subset of the overall DoD plans for Continuous Acquisition and Life-cycle Support (CALS) and for electronic commerce as part of Acquisition Reform. To reflect the focus on that subset, the program name was changed in FY 1994 from CALS Shared Resource Centers to Electronic Commerce Resource Centers (ECRCs). The regional ECRCs provide training and technical assistance to aid SMEs in Defense supply chains in making effective use of electronic commerce and CALS technologies. An ECRC technology hub has been established to keep abreast of EC technologies and to ensure that technical consultants in the regional ECRCs are equipped with the latest information and training on EC technologies. This program will be transitioned to the Defense Logistics Agency at the end of FY 1997.

(U) **Program Accomplishments and Plans:**

(U) FY 1997 Accomplishments:
- Electronic Commerce Resource Centers (ECRC). ($34.3M)
  - Opened five new ECRCs.
  - Completed DARPA funded ECRC technology development and deployment.
  - Transitioned program to the Defense Logistics Agency (DLA) for continued operation.

(U) FY 1998 Program: N/A

(U) FY 1999 Program: N/A

(U) **Program Change Summary:**

(In Millions)	FY 1997	FY 1998	FY 1999
President's Budget	20.7	15.0	0
Appropriated	34.3	N/A	N/A
Current Budget	34.3	0	0

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APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 3 Advanced Technology Development

R-1 ITEM NOMENCLATURE
Advanced Electronics Technologies,
PE 0603739E, Project MT-11

(U) **Change Summary Explanation:**

FY 1998 Program transfers to Defense Logistics Agency.

(U) **Other Program Funding Summary Cost:**   *(In Millions)*

	FY 1997	FY 1998	FY 1999
0603753S	0	15.0	0

(U) **Schedule Profile:** N/A

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APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 3 Advanced Technology Development

R-1 ITEM NOMENCLATURE
Advanced Electronics Technologies,
PE 0603739E

COST (In Millions)	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Microelectromechanical Systems (MEMS) MT-12	60,844	73,158	71,549	72,281	50,000	49,000	41,000	Continuing	Continuing

(U) **Mission Description:** The Microelectromechanical Systems (MEMS) program is a broad, cross-disciplinary initiative to develop an enabling technology that merges computation with sensing and actuation to realize new systems for both perceiving and controlling weapons systems, processes and battlefield environments. Using fabrication processes and materials similar to those that are used to make microelectronic devices, MEMS conveys the advantages of miniaturization, multiple components, and integrated microelectronics to the design and construction of integrated electromechanical systems. The MEMS program addresses issues ranging from the scaling of devices and physical forces to new organization and control strategies for distributed, high-density arrays of sensor and actuator elements. The microfluidic molecular systems program will address issues centered around the development of automated microsystems that integrate biochemical fluid handling capability along with electronics, opto-electronics and chip-based reaction and detection modules to perform tailored analysis sequences for monitoring of environmental conditions, health hazards, and physiological states.

(U) The MEMS program has three principal objectives: the realization of advanced devices and systems concepts; the development and insertion of MEMS products into DoD systems; and the creation of support and access technologies to catalyze a MEMS technology infrastructure. These three objectives cut across a number of focus application areas to create revolutionary military capabilities, make high-end functionality affordable to low-end systems, and extend the operational performance and lifetimes of existing weapons platforms. The major technical focus areas for the MEMS program are: 1) inertial measurement; 2) fluid sensing and control; 3) electromagnetic and optical beam steering; 4) mass data storage; 5) chemical reactions on chip; 6) electromechanical signal processing; 7) active structural control; 8) analytical instruments; and 9) distributed networks of sensors and actuators.

(U) Among the many accomplishments to date are: a wind-tunnel test of an integrated MEMS sensor and actuator array distributed along the leading edge of a model aircraft wing creating rolling moments of sufficient strength to control aircraft flight, pointing the way to future fighter aircraft with advanced maneuverability unattainable using conventional, large and discrete control surfaces; a demonstration of a MEMS-based accelerometer capable of surviving and operating in the near 100,000 G accelerations generated by firing artillery shells, making possible affordable guidance systems to what are presently unguided munitions and increasing both their effectiveness and life cycle costs; and the establishment of a regularly scheduled, shared, MEMS fabrication service for domestic DoD, commercial

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Advanced Electronics Technologies, PE 0603739E, Project MT-12

DATE: February 1998

and academic users. The MEMS program has initiated new efforts in: low power miniaturized communications systems; distributed control aircraft roll and yaw; microscale power; micro airborne sensor/communication systems; data storage; and inertial systems.

(U) **Program Accomplishments and Plans:**

(U) FY 1997 Accomplishments:

- Achieved additional factor of 5-10x increase in electronics-to-mechanics integration ratios; explored space of related device designs and architectures enabled by order-of-magnitude increase in integration ratios including electromechanical signal processing elements and radio-frequency components; continued development of fault-tolerant and parallel designs including low-noise, low-drift multi-axis accelerometers and gyroscopes; demonstrated extreme temperature and pressure sensor function in operational environments. ($9.7M)

- Achieved 400-500 mechanical components/sq. cm systems densities with integrated or hybrid fabrication/assembly techniques; demonstrated MEMS applications using massively parallel MEMS components; initiated new dual-use areas including analytical instruments, precision assembly, on-demand structural strength enhancement and air-vehicle aerodynamic control; began creation of shared testbed for development and validation of new organizational and control strategies for large-scale, distributed MEMS. ($25.2M)

- Investigated MEMS Plasma Processing development at congressional direction. ($4.9M)

- Investigated Peizoelectric MEMS development at congressional direction. ($2.0M)

- Began transition of mature fabrication services to self-sufficiency; demonstrated scalable distributed fabrication services for MEMS process experimentation; continued development of MEMS-specific unit processes and associated processing equipment; continued the extension of simulators to address the modeling and coupling of multiple physical forces encountered in MEMS applications; continued dissemination and validation of CAD tools and design libraries. ($5.5M)

- Initiated plans to develop on-chip integrated microfluidic systems for improved detection and control of molecular reactions with emphasis on the development of new materials and control of reactions. ($13.5M)

(U) FY 1998 Program:

- Devices and Processes - Accelerate and expand on MEMS system developments that exploit physics and MEMS systems architecture to project micro-scale actions into macro-scale effects such as micro-optomechanical scanners, switches, displays, adaptive optics and aligners. ($20.9M)

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APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE	DATE February 1998
RDT&E, Defensewide BA 3 Advanced Technology Development	Advanced Electronics Technologies, PE 0603739E, Project MT-12	

- System Design and Development - Extend present fabrication processes to cost-effective, large area fabrication approaches. ($22.6M)

- Support and Access Technologies - Integrate developments in MEMS, robotics and ultra-electronics to design, construct and field multiple, high-performance, mobile, autonomous systems. ($8.6M)

- Microfluidics - Initiate system-level integration through an evolving testbed strategy in which the development of new microfluidic components and processes occurs concurrently with the integration of early prototypes with available chip-based molecular analysis components. Leverage analysis and detection technology from industry, Services, and other DoD programs when compatible with microsystems integration. ($17.3M)

- Continue Center for Advanced Microstructures Devices (CAMD). ($3.8M)

(U) FY 1999 Program:

- Devices and Processes - Demonstrate radio-frequency electromechanical filtering, processing, and beam steering and atomic-resolution data storage using precision, parallel read/write structures. ($10.0M)

- System Design and Development - Initiate concept demonstrations for systems in the form of model aircraft and weight-supporting structures, and additional concepts in areas including identify friend-or-foe systems, on-chip chemical processing, and mobility. ($34.5M)

- Support and Access Technologies - Address the key barriers in MEMS fabrication, packaging and integration to realizing system demonstrations that will be critical to DoD validation and insertion of MEMS technology. ($11.0M)

- Microfluidics - Continue system-level integration on new microfluidic components and processes. ($16.0M)

(U) **Program Change Summary:** *(In Millions)*

	FY 1997	FY 1998	FY 1999
President's Budget	62.2	72.1	71.5
Appropriated	59.2	73.3	N/A
Current Budget	60.8	73.2	71.5

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APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide	Advanced Electronics Technologies,
BA 3 Advanced Technology Development	PE 0603739E, Project MT-12

(U) **Change Summary Explanation:**

FY 1997 Increase reflects increased efforts in microfluidic components and processes.
FY 1998 Decrease reflects minor program repricing.

(U) **Other Program Funding Summary Cost:** N/A

(U) **Schedule Profile:**

Plan   Milestones
Jan 98   Self-sufficiency of mature shared fabrication services.
Jun 98   Controlled chemical reactions and processing on chip.
Jan 99   Atomic-resolution data storage using precision, multiple read/write structures.
Apr 99   Local micro encapsulation of navigation-scale inertial measurement units (IMU).
Nov 99   Micro-assembled electromechanical signal processing.
Apr 00   MEMS aerodynamic pressure sensors or flexible adhesive tape substrate.
Jun 00   Modular, monolithically integrated MEMS IMU.
Sep 00   MEMS high temperature sensor and actuator arrays.

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DATE   February 1998

APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 3 Advanced Technology Development								R-1 ITEM NOMENCLATURE Maritime Technology PE 0603746E, R-1 #44	
COST *(In Thousands)*	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Shipbuilding Technology MR-01	47,347	36,030	15,000	0	0	0	0	0	N/A

(U) **Mission Description:** The goal of the MARITECH Program is to preserve the U.S. shipbuilding industrial base by improving the industry's commercial competitiveness through advanced technology applications. For the Defense Department, a competitive shipbuilding industry optimizes Navy ship acquisition reform and allows realization of the Department's objective for affordable Navy ships. The goal of the DoD Acquisition Reform Program is to take advantage of the best commercial practices of industry and thereby achieve cost reductions of the ships and systems it purchases. Having operated exclusively in a protected domestic market, the U.S. shipbuilding industry has not implemented the best commercial processes necessary to compete in the international arena or to build affordable Navy ships. The government's attempt at acquisition reform, as it applies to ship acquisition, could fall short if U.S. shipyards are not commercially competitive. The key for acquisition reform is for the U.S. shipbuilding industry to attain global commercial competitiveness.

(U) MARITECH is a two-phased program that provides products and infrastructure for the near and long term. The near term effort enhances international competitiveness through the development of a portfolio of U.S. ship designs for the international marketplace and the build strategies for their competitive price and delivery. This effort is being enhanced by developing an infrastructure that includes the implementation of electronic communications and commerce throughout the industry, and by participating in an industry-wide forum for problem solving on a technical level.

(U) The long term effort includes the infusion of innovative product technologies and process improvements that brings the capabilities of the U.S. shipbuilding industry above those of foreign shipyards. This will result in a larger share of the international market, and a self-sustaining, highly efficient U.S. shipbuilding industry.

(U) **Program Accomplishments and Plans:**

(U) FY 1997 Accomplishments:
- Completed advanced technology developments for improving ship production processes and products initiated in prior years. ($17.6M)
- Completed advanced shipbuilding strategies and commercial ship design initiatives from prior years. ($7.9M)
- Continued to improve and provide support for National Shipbuilding Network (NSnet). ($.1M)
- Expanded Electronic Commerce and Computer Integrated Enterprise. ($4.1M)

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APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide	Maritime Technology,
BA 3 Advanced Technology Development	PE 0603746E, Project MR-01

(U) • Initiated nine advanced technology demonstration projects to improve Enterprise-wide Systems and develop Advanced Business Practices. ($17.6M)

(U) FY 1998 Program:
- Complete Total Process Systems development projects initiated in FY 1997. ($9.0M)
- Complete Advanced Business Practices development projects initiated in FY 1997. ($11.3M)
- Complete development of standard data exchange translators for digital ship design and construction. ($3.2M)
- Complete advanced technology development projects initiated in FY 1996. ($3.6M)
- Complete Electronic Commerce and Computer Integrated Enterprise project commenced in FY 1996. ($3.1M)
- Develop and initiate a long range national level, technology development strategy with National Shipbuilding Consortium. ($5.2M)
- Continue to improve and provide support for National Shipbuilding Network (NSnet). ($.3M)
- Initiate Commercial Cruise Ship Study. ($.3M)

(U) FY 1999 Program:
- Initiate research projects in the following areas: Advanced Ship Production Processes; Advanced Product Design and Manufacturing Technologies; and Electronic Customer and Supplier Interaction. ($15.0M)

(U) **Program Change Summary:** *(In Millions)*

	FY 1997	FY 1998	FY 1999
President's Budget	49.0	37.4	12.6
Appropriated	49.0	36.0	N/A
Current Budget	47.3	36.0	15.0

(U) **Change Summary Explanation:**

FY 1997 Decrease reflects $1.1 million reprogrammed to SBIR Program.
FY 1999 Increase reflects repricing of DARPA MARITECH program.

(U) **Other Program Funding Summary Cost:** N/A

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APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 3 Advanced Technology Development

R-1 ITEM NOMENCLATURE
Maritime Technology,
PE 0603746E, Project MR-01

(U) **Schedule Profile:**

Plan   **Milestones**

Jun 98   Complete test and evaluation of System Life Cycle Support Infrastructure Demonstration Project.

Sep 98   Complete development and test of integrated Product Data Environment for Shipbuilding.

Sep 98   Complete final 6 ship designs for International Commercial marketplace.

Sep 98   Complete remaining 10 process and product technology development projects initiated in FY 1995.

Sep 98   Complete development of long range technology development strategy for US shipbuilding industry.

Jul 99   Complete prototype demo and development of commercialization plan for next generation PC based system
          for Integrated Product and Process Development.

Jan 99   Initiate research projects for shipbuilding technology development.

Jul 99   Complete development of National Shipbuilding Information Infrastructure Protocols.

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APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 3 Advanced Technology Development

R-1 ITEM NOMENCLATURE
Electric Vehicles
PE 0603747E, R-1 #45

COST (In Millions)	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Electric Vehicles EV-01	14,693	14,522	0	0	0	0	0	0	N/A

(U) **Mission Description:** Electric and hybrid electric drivetrains provide compelling advantages for future tactical and combat vehicles. Of particular importance is a 50-percent reduction in fuel consumption due to higher efficiency, improved acceleration and maneuverability due to immediate torque to the wheels or tracks, and dramatically reduced thermal and acoustic signatures when operating from on-board energy storage. Affordability is addressed through reduced logistics requirements and the dual use applications of these technologies.

(U) The DARPA Electric and Hybrid Vehicle Technology program is pursuing research, development, and demonstrations of technologies for electric and hybrid vehicles that address military missions, modernization, and cost mitigation. Established by Congress in FY 1993, the program has pursued technology development and prototype demonstrations that are essential for future military systems, enhancing national energy security, and facilitating compliance by the Armed Services with federal clean air legislation. DARPA uses a unique decentralized management approach working directly with seven regional consortia. These diverse consortia provide a minimum of 50% of the funding and cooperatively function to overcome the challenges of developing electric and hybrid vehicle technologies. Consortium participants include military laboratories and bases, state and local governments, large and small defense contractors, well-established and startup manufacturers of vehicles and components, electric and gas utilities, public interest groups, and universities. Military requirements and infrastructure are implemented within this program at minimal federal investment, leveraging significant funds.

(U) Technology development is focused on: High-specific power engine/generator sets, including multi-fuel capable, high efficiency, and low emissions turbines, diesels, and rotary engines; Power control devices, including high-performance power semiconductors, control algorithms, and circuit integration and packaging; Energy storage devices, including advanced batteries, rapid battery recharging, flywheels, and capacitors; electromechanical conversion, including alternating current and direct current, and linear motors; and lightweight high-strength materials, including space-frames and composites. These dual-use electric drivetrain technologies are being demonstrated in both commercial and military chassis. The technologies are directly relevant and are coordinated with the DARPA Combat Hybrid Power Systems (CHPS) and Reconnaissance Surveillance and Targeting Vehicle programs (budgeted under LNW-01). The CHPS program is developing an integrated electric power system to provide both continuous and pulsed power to all of the subsystems on a combat vehicle including weapons, C3I, countermeasures as well as the electric drivetrain developed in this program.

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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

| DATE | February 1998 |

APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide	Electric Vehicles,
BA 3 Advanced Technology Development	PE 0603747E, Project EV-01

(U) **Program Accomplishments and Plans:**

(U) FY 1997 Accomplishments:
- Developed and started field testing of hybrid electric combat vehicles. ($2.8M)
- Developed and tested medium and heavy duty electric and hybrid electric commercial vehicles. ($1.9M)
- Developed and tested improved auxiliary power units for medium and heavy hybrid electric vehicles. ($1.4M)
- Built and tested flywheel energy storage units with containment. ($2.2M)
- Developed reliable batteries, battery management systems, and rapid chargers. ($3.9M)
- Developed and tested drive train and other components. ($1.6M)
- Completed Hybrid Electric Drive simulation and modeling. ($.9M)

(U) FY 1998 Program:
- Complete development and field testing of hybrid electric High Mobility Multi-Purpose Wheeled Vehicles (HMMWVs), M1113, and Bradley Fighting Vehicle and build hybrid electric Composite Armored Vehicle. ($3.6M)
- Develop and test additional medium and heavy duty hybrid electric vehicles. ($3.5M)
- Develop and test turboalternator and other auxiliary power units for medium and heavy hybrid electric vehicles. ($2.4M)
- Further integrate and test flywheel energy storage units with containment. ($1.5M)
- Develop and test improved and reliable batteries and battery management systems. ($1.5M)
- Develop and test improved drivetrain and other components of hybrid electric vehicles. ($2.0M)

(U) FY 1999 Program: N/A

(U) **Program Change Summary:**

	(In Millions)	FY 1997	FY 1998	FY 1999
President's Budget		14.7	0	0
Appropriated		14.7	14.5	N/A
Current Budget		14.7	14.5	0

(U) **Change Summary Explanation:** N/A

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE	February 1998

APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 3 Advanced Technology Development		R-1 ITEM NOMENCLATURE Electric Vehicles, PE 0603747E, Project EV-01

(U) **Other Program Funding Summary Cost:** N/A

(U) **Schedule Profile:**

Plan   Milestones

Mar 98   Complete demonstration of hybrid electric propulsion of second High Mobility Multi-purpose Wheeled
           Vehicle (HMMWV).

Apr 98   Complete field test of hybrid electric HMMWV.

May 98   Complete preliminary designs of turboalternators for hybrid electric vehicles.

Oct 98   Complete field test of hybrid electric M113.

Dec 98   Complete testing of rapid charging units.

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		DATE February 1998

APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 3 Advanced Technology Development	Command, Control and Communication Systems, PE 0603760E, R-1 #50

COST (In Thousands)	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Command, Control and Communication Systems	**98,840**	**150,010**	**200,100**	**187,369**	**206,234**	**212,034**	**211,034**	**Continuing**	**Continuing**
Command & Control Information Systems CCC-01	43,489	64,125	81,200	88,569	106,034	106,734	105,034	Continuing	Continuing
Information Integration Systems CCC-02	55,351	85,885	118,900	98,800	100,200	105,300	106,000	Continuing	Continuing

(U) **Mission Description:** This program element is budgeted in the Advanced Technology Development Budget Activity because its purpose is to demonstrate and evaluate advanced information systems research and development concepts.

(U) The Command and Control Information Systems Project is developing the technologies necessary to facilitate joint campaign planning and control throughout the battlespace. The primary program in this project is the Joint Forces Air Component Command System (JFACC), which will revolutionize command and control of joint and coalition air forces through the incremental development, integration, evaluation, demonstration, and transition of technology and systems. Other programs addressed in this project includes: the Integrated Battlespace program, the Advanced Joint Planning (AJP) advanced concept technology demonstration, the Advanced Cooperative Collection Management (ACCM) program, the Agent-Based Systems program, and the Speakeasy program.

(U) The information Integration Systems project will develop the technologies necessary to ensure that the enhanced information required by battlefield combatants is available on a near real time basis. Programs addressed in this project include the Dynamic Multi-User Information Fusion (DMIF) program, the Dynamic Database (DDB) program, the Battlefield Awareness and Data Dissemination (BADD) Advanced Concept Technology Demonstration (ACTD), the Airborne Communications Node (ACN) program, and the Command Post of the Future program.

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APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 3 Advanced Technology Development

R-1 ITEM NOMENCLATURE
Command, Control and Communications Systems,
PE 0603760E

COST (In Thousands)	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Command Control Information Systems CCC-01	43,489	64,125	81,200	88,569	106,034	106,734	105,034	Continuing	Continuing

(U) **Mission Description:** Recent military operations, e.g., Desert Storm and Haiti, demonstrated that current theater command, control, communications, intelligence/information systems, planning and rehearsal systems; and non-lethal weapon's capabilities lack the ability to support effective operations in diverse new arenas and scenarios ranging from desert heavy battle actions to urban areas with large civilian populations. Current capabilities do not provide real-time situational awareness, decentralized battle planning, rehearsal and execution capability, flexible interfaces or critical interoperable wide-area communications. The goals of the programs in this project are to build on an innovative architecture and infrastructure to enhance information processing, dissemination and presentation capabilities for the Commander by inclusion of information pertaining to enemy and friendly forces, providing a joint situational awareness picture and improving planning, decision-making and execution support capability and providing multi-media information interfaces and software to "on-the-move users". Integration of collection management, planning and battlefield awareness programs is an essential element of our strategy for achieving battlefield dominance through information systems.

(U) The Joint Forces Air Component Commander (JFACC) Program seeks to revolutionize command and control (C2) of joint and coalition air forces through the incremental development, integration, evaluation, demonstration and transition to the Warfighter of technology and systems which will enable new operational concepts for planning and execution that will significantly improve the responsiveness, efficiency and effectiveness of air operations. Key aspects of the program are: continuous near-real-time planning and execution with all tasks tied to a central strategy and embodied in a common plan representation; collaboration among distributed elements to achieve a high degree of integration through the echelons and across operations, intelligence and logistics; and end-to-end management of C2 operations including advanced capabilities for strategy development, target systems analysis, campaign assessment and resource planning. Key technologies include: centrally managed, multi-stage, concurrent plan generation; planning agents; intelligent resource scheduling techniques; dynamic resource reallocation algorithms; adaptive cueing tools; automated information routers; information tailoring and visualization tools and advanced collaborative and workflow management tools. These technologies will be applied to requirements that include: continuous mission planning processes that quickly anticipate and react to changes in guidance, threat situation, resource availability and synchronization needs; full integration of intelligence, logistics and

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R-1 ITEM NOMENCLATURE
Command, Control and Communications Systems,
PE 0603760E, Project CCC-01

operational activities to support strike operations and prioritized target nomination, information gathering and logistics support functions of the component commander; empowerment of cross functional planning teams to quickly respond to changes; and proper battlefield knowledge to support activities and decisions at multiple echelons. JFACC technologies, that support operational level decision making and information processing, will be extended to maritime and land component C2 systems supporting joint force operations and associated planning tools will be made interoperable with related DARPA and Service programs (e.g. Advanced Logistics Project (ALP), Advanced ISR (Intelligence, Surveillance, and Reconnaissance) Management (AIM), and Battlefield Awareness and Data Dissemination (BADD)). Program execution features a multi-phased, develop-demonstrate-transition approach, including close coordination with the Air Force and Navy Battlelabs, the Advanced Information Technology Services (AITS) Joint Program Office (JPO), and other service C2 organizations.

(U)   The Integrated Battlespace (IB) Program will extend emerging information technologies and develop new methods to integrate joint force planning tools and operations management software applications. IB focuses on extending capabilities across service components (e.g., air, land, maritime) as well as between functional components (e.g., intelligence, operations, logistics, command-and-control warfare). The program will leverage technology from the JFACC program, Advanced Logistics, Planning and Decision Aids, and Genoa to coordinate and synchronize joint operations. IB will develop technology to support force allocation decision-making based on the CINC and Joint Task Force Commander's intent.

(U)   With the growing dependence on information systems and the pressing need to be able to get the right information to the right person at the right time, it becomes critical to deliver and protect information and assure the availability of associated services -- particularly in a stressed environment. Information Assurance (IA) technologies will be integrated into future versions of the Defense Information Infrastructure (DII) Leading Edge Services (LES) to provide a robust architecture across a wide range of DoD information systems. The development and fielding of secure information systems will be a continuing process of development and upgrading of existing systems and capabilities. The program is developing and refining information security technology into the LES architecture and testbed. The resulting security framework will reduce information vulnerability, allow increased interoperability and functionality, and provide the operational commander greater assurance that he will have the information he needs when he needs it. The initial investment provides: near term applications to provide a modest level of protection and a mechanism to test advanced secure information development in an end to end environment.

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(U)   The Advanced Joint Planning (AJP) ACTD was evaluated by US Atlantic Command (USACOM) and they determined that the AJP ACTD had "Military Utility" and is in the "leave behind" status. The Program Management was transitioned to the AITS JPO for the "leave behind".

(U)   A new generation of collection systems will provide dramatically increased volumes of higher fidelity data to the operational decision maker. The challenge will be to dynamically manage and synchronize this advanced collection architecture with the next-generation processing, exploitation, and dissemination capabilities to provide the critical information to the decision maker in the constantly changing operational situation. The Advanced ISR (Intelligence, Surveillance, and Reconnaissance) Management (AIM) project (formerly named Advanced Cooperative Collection Management (ACCM) Program) will expand on efforts begun under the JFACC program and provide the technical foundation for ISR support to JV2010 through the development of Information Management, Collection Strategy Development, and Multi-asset Synchronization capabilities to dynamically optimize/synchronize, schedule, and task the spaceborne, airborne and ground based collection, processing, exploitation and dissemination architecture. The AIM project will optimize ISR support to precision engagement and dominant maneuver by providing proactive information support to the warfighter, continuous collaboration between Operations and ISR, responsive ISR timelines, optimal ISR confederation management, and synchronization of ISR asset and exploitation tasking. AIM's Information Management effort will insure near-real-time (NRT) information support to commanders and the Joint Task Force (JTF) by providing all echelons with: a common view of the collection environment; current status of collection, processing, exploitation, and dissemination operations; faster than real-time simulations in support of trade-off decisions; and the ability to conduct real-time multi-echelon coordination and shared decision making. AIM's Collection Strategy Development effort will interoperate with future automated operational plan representations to continuously interpret ISR requirements contained in the plan and decompose these requirements into discrete sensor, information retrieval, and exploitation tasks. AIM's Multi-Asset Synchronization effort will simultaneously plan and integrate platform routes and schedules that maximize the total information value from the ISR confederation in support of the operational plan. The AIM project will develop or advance technologies in the following areas: workflow management, multi-node collaboration, social computation, automated reasoning, mathematical programming, and cognitive presentations. Resulting AIM capabilities will transition to DoD automated planning and C4ISR migration systems as appropriate.

(U)   The Agent-Based Systems Program will develop control strategies that enable intelligent assistants for warfighters allowing them to delegate tasks such as information gathering, logistics supply, and operations planning that can be automated, but currently overload military personnel. Unlike other software, agents reduce the users

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workload by operating autonomously and using available information to make intelligent decisions on behalf of the user. Agents are cost-effective; adaptive to new users, tasks, and computing environments; and collaborate with other agents on the network to solve problems. Commercial industry is rapidly adopting intelligent agent technology because it potentially lowers software development costs and automates user tasks. However, being autonomous, agents can misinterpret user requests, go out of control, consume system resources, destroy user confidence, and eliminate any advantage to developers. Systems of agents produced by different developers can interact in complex ways. The Agent-Based Systems Program will complement commercial investment by developing control strategies to ensure heterogenous agent systems work correctly and predictably in the evolving Defense Information Infrastructure. The program begins in FY 1998 and continues through FY 2002.

(U) The Speakeasy Program demonstrated a software-programmable communication system in a tactical environment. Speakeasy, which operates over the 2 Mhz to 2 Ghz band, provides the capability to implement wireless communications concepts to meet Service requirements. Speakeasy is an open architecture-based, software-programmable communications terminal supporting simultaneous operation on a minimum of six radio frequency waveforms (four programmable channels in addition to ones for the global positioning system and cellular). The program is transitioning to the Services within the Programmable Modular Communications System (PMCS) Architecture in FY 1998.

(U) **Program Accomplishments and Plans:**

(U) FY 1997 Accomplishments:

- Conducted phase one "proof-of-concept" warfighter demonstration of prototype components at the USAF Battle Management Battle Lab, Hurlburt AFB, FL in Jan 97. Prototype components included: Air operations resource allocation and scheduling tools, campaign assessment process, workflow management control of the planning process, ISR and logistics planner, and target system analysis toolset. Initiated second phase of system development -- basic technology/application building blocks and system architecture for the JFACC Program advanced operational and technical concepts. ($18.7M)
- Defined information survivability threats, from internal failures or external attacks. ($2.0M)
- Developed threat-based design strategies and required near-term product-extensions. ($4.5M)
- Defined standard information warfare (IW) attack set to measure progress towards attack resiliency. ($2.0M)
- Based on prior year evaluation, completed the design, accomplished modifications and installed of a "leave behind" operational system, which can then be replicated for other CINCs. The system provided USACOM an

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automated joint readiness management system, a joint planning and evaluation toolkit. Transitioned selected components to the current Defense Information Infrastructure (DII) Common Operating Environment (COE) version via the Advanced Information Technology Services Joint Projects Office (AITS JPO). ($8.8M)

- Completed the development of several waveforms, i.e. SINCGARS (VHF), HAVE QUICK (UHF), HF Single Side Band, UHF SATCOM, and the Air Traffic Control (VHF) and demonstrated capability at the National Training Center in the Army Task Force XXI Advanced Warfighting Experiment (AWE) by the 1st Brigade 4th Infantry Division. ($6.5M)

- Conducted an Advanced ISR Management (AIM) (was ACCM) Concept Validations with prototype components: Requirements and Priority Manager, Multi-Asset Manager, and WarFighter Interface. Released BAA for follow-on program development. ($1.0M)

(U) FY 1998 Program:

- Demonstrate and evaluate the basic technology/application building blocks and system architecture for the JFACC Program (Phase 2). Develop JFACC Phase 3 capabilities - an initial integrated campaign management and continuous planning and execution ability. Develop the combined benefit of operational systems analysis and campaign assessment leading to an increase in mission cost effectiveness by a factor of three. Develop and demonstrate common communication protocols and resource protection strategies for Agent-Based Systems. Demonstrate interoperability with several related ISO Programs and the DII/GCCS. ($31.3M)

- Develop initial integrated joint force planning tools and operations management software applications for implementation in a joint command center. ($3.0M)

- Demonstrate Information Assurance (IA) automated capabilities to limit system access, and prevent system attacks by layering privacy security service over enclave-to-enclave protection and filtering out active code that is dangerous to enclave systems. Demonstrate gross responses for disabling attacks by shutting down outside connection and system-wide recovery. Demonstrate mechanism interoperability with negotiation protocols and good system administration tools to manage security mechanisms in DII LES. Integrate a basic Public Key Infrastructure certificate management system to support basic security services. ($20.0M)

- Award AIM development contracts for initial Measures of Military Utility, trade studies and trade-off analysis, and design tools for information management, strategy development, and multi-asset synchronization. Conduct a Concept Validation demonstration of emerging multi-asset synchronization algorithms. ($7.9M)

- Complete the transition and provide one year of maintenance support to the operational Advanced Joint Planning ACTD to USACOM. Conduct a formal assessment of the ACTD's functionality. Complete transition of selected components to the current DII COE version via the AITS JPO. ($1.9M)

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(U) <u>FY 1999 Program</u>:

- Demonstrate, evaluate and initiate transition of JFACC Phase 3 capabilities to service battlelabs and the AITS JPO. Develop JFACC Phase 4 capabilities - a robust, integrated campaign management and continuous planning and execution capability that achieves 70% of all responsiveness, resource efficiency, campaign effectiveness and process flexibility goals. ($37.1M)

- Demonstrate automated capabilities to limit system access, protect data, manage replication and recovery, provide advanced detection and response to intrusions, anti-flooding techniques, and reconstitute/ reconfigure information services to reflect dynamic operational priorities. Demonstrate capability to do integrated monitoring of network service data, detected intrusion status and configuration/reconfiguration and to manage allocation of components and resources dynamically to reconstitute critical functions that have been degraded. ($20.0M)

- Develop AIM tools for information management, strategy development, and multi-asset synchronization. Demonstrate initial proof-of-concept with loosely integrated components in a simulated environment. ($10.0M)

- Develop and test cooperative, federated, and market-based control strategies for Agent-Based Systems to assist information gathering and enhance military planning capabilities. ($14.1M)

(U) **Program Change Summary:** *(In Millions)*

	FY 1997	FY 1998	FY 1999
President's Budget	47.8	67.4	67.1
Appropriated	41.2	62.5	N/A
Current Budget	43.5	64.1	81.2

(U) **Change Summary Explanation:**

FY 1997   Reflects minor repricing of programs and realignment of funds.
FY 1998-99   Increases reflect expansion of Agent-Based Systems Program from within JFACC Program.

(U) **Other Program Funding Summary Cost:**   N/A

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RDT&E, Defensewide
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Command, Control and Communications Systems,
PE 0603760E, Project CCC-01

(U) **Schedule Profile:**

Plan	Milestones
Mar 98	Demonstrate JFACC Phase 2 - prototype JFACC planning and execution infrastructure/tools.
Jul 98	Integrate COTs security, security APIs, and detect intrusion tools in GCCS LES Release 3.x
Sep 98	AIM multi-asset synchronization participation in DARPA Information Superiority Demonstration (ISD) 98.
Sep 98	Demonstrate automated capabilities to limit system access, protect data, manage replication and recovery, detect and respond to intrusions, and reconstitute/reconfigure information services.
Dec 98	Detect 80% of IW attack set, disable attacks by shutting down outside connection and system-wide recovery by system rollback to condition prior to attack.
Apr 99	AIM demonstration of single-asset-to-task multi-asset synchronization in a simulated environment.
Jun 99	Demonstrate computer network resource protection for pathogenic agent systems.
Sep 99	Demonstrate JFACC Phase 3 - integrated campaign management and continuous planning and execution capability.
Sep 99	Integrate a basic Public Key Infrastructure certificate management system to support basic security services. Demonstrate basic replication techniques and anti-flooding techniques (port filtering).
Jun 00	Demonstrate collaboration in multi-agent systems developed without hard-coded interfaces.
Jun 01	Demonstrate agents that dynamically create software interfaces; define scalability limitations.
Jun 02	Demonstrate agent-based software technology for creating "super-applications" at run time.

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COST *(In Millions)*	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Information Integration Systems CCC-02	55,351	85,885	118,900	98,800	100,200	105,300	106,000	Continuing	Continuing

(U) **Mission Description:** The goals of this project are to take diverse inputs, including those planned as outputs from the PE 06063762E Sensors and Exploitation Systems project (SGT-04), and perform distributed and dynamic all-source correlation and fusion to produce an integrated, geo-spatially referenced, battlefield database and knowledge-base, and through the use of wideband dissemination and integrated sensor management allow multi-site, real-time, collaborative situation assessment and course-of-action evaluations. These goals are being addressed by the Dynamic Multi-User Information Fusion (DMIF) program, the Dynamic Database (DDB) program, the Battlefield Awareness and Data Dissemination (BADD) Advanced Concept Technology Demonstration (ACTD), the Airborne Communications Node (ACN) program, and the Command Post of the Future (CPoF) program.

(U) The Dynamic Multi-User Information Fusion (DMIF) program is the premiere fusion advanced technology development program for the defense and intelligence communities, including next-generation automated capabilities to support the operational service fusion systems: All Source Analysis System (ASAS), Theater Battle Management Care System (TBMCS), and Global Command and Control System (GCCS). The program is developing and inserting a product line of fusion capabilities that combine information from multiple sensor-based sources (eg, IBS broadcasts, SAIP outputs, HUMINT reports, and NRTI SIGINT information) as well as outputs from multiple fusion engines (such as those resident within TBMCS, ASAS, the Common Ground Station (CGS), or Regional SIGINT Operations Centers (RSOCs)). Any given insertion of DMIF would combine, focus, and rectify information from these disparate sources to provide the joint warfighter with a clear and actionable picture of the battlespace. This DMIF-created picture will reduce information overload and overcome barriers to interoperability among sensor exploitation sites, intel processing sites, and operators' decision nodes. DMIF will strategically control the multiple fusion resources found at such sites in order to create real-time mission focused pictures of the battlespace (related to the Common Operational Picture). DMIF is also building a series of low-cost applications (Product Finishers) to provide "finished" situation information products to a wide variety of operations systems, including applications for targeting, Suppression of Enemy Air Defenses (SEAD), maneuver control, and logistics planning. In all these efforts, a key DMIF program objective and measure of success is focused, rapid and effective transition of advanced fusion technology to warfighters via technology transition efforts already underway with GCCS, ASAS, and the DARPA-DISA Joint Program Office.

(U) The overarching goal of the Dynamic Database (DDB) program is to continuously produce significant battlespace information from immense quantities of multi-sensor data in a manner responsive to a diverse user community.

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More specifically, the DDB program will design, build, and demonstrate a system that (1) provides ready access to all battlespace sensor observations collected over time, (2) uses the resulting sensor history to identify and focus users' attention on tactically significant battlespace events, and (3) shares and synchronizes local situation changes across the distributed battlespace. Dynamic Database contents will be maintained and shared through a Dynamic Situation Model (DSM) that integrates geo-registered sensor history data with terrain, environmental, and force information to yield a logically consistent, multi-level view of the battlespace. Single and multi-sensor data fusion approaches will be developed that efficiently update the DSM by filtering tactically significant changes from the Dynamic Database sensor history. This objective includes the development of theory and techniques for incorporating mission and situation context into low-level processing algorithms, and advanced phenomenology models for translating expected conditions and behaviors into multi-sensor observables. Significant situation changes will be shared throughout the battlespace within a scaleable "DDB enterprise" of distributed DSM nodes, computing applications, processors, and information repositories. DDB enterprise technologies will be developed to monitor database conditions for change, trigger external processes when conditions meet posted criteria, propagate changes across DSM nodes, and support queries and searches of distributed databases.

(U) The objective of the Battlefield Awareness and Data Dissemination (BADD) Advanced Concept Technology Demonstration (ACTD) is to deliver, install and evaluate an operational prototype system that delivers to warfighters a consistent operational picture of the joint/coalition battlefield, allows commanders to design/tailor their own information system, and provides access to key transmission mechanisms and worldwide data repositories. The description of the battlespace provided to the warfighters under this ACTD will be tailored to their mission needs by intelligent selection of information to be broadcast, intelligent processing of user requests (pull) and filtering at the warfighter workstation so that needed information is available. BADD will be evaluated through participation in exercises and demonstrations, and by insertion into ongoing pilot services, such as the Joint Broadcast Service installed in the European Theater in April 1996. BADD is also operating under a Memorandum of Agreement with the Global Broadcast Service Program Office to provide advanced information management capabilities and new applications for this system as part of the overall plan of transition of BADD developments to operations after test and evaluation in the ACTD. Selected applications and dissemination services will be transitioned to the Defense Information Systems Agency (DISA) for incorporation into the Defense Information Infrastructure Common Operating Environment (DII/COE).

(U) The Airborne Communications Node (ACN) program will provide range extension and rapid deployment for many new and existing military communications systems. This is achieved through the placement of a highly flexible, software reprogrammable radio communication system on the Global Hawk High Altitude Endurance unmanned airborne platform. The ACN will connect isolated and rapidly maneuvering forces via high data rate communications, provide reach-back

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connectivity to CONUS from forward elements, and allow gateway connectivity among dissimilar radios. The Airborne Communications Node program will integrate Warfighter Internet functionality to provide PCS/cellular-like communication services (voice, data, broadcast, paging) to small handheld terminals. The program will conclude with field demonstrations in FY 2002.

(U)   The objective of the Command Post of the Future (CPoF) program is to improve the speed and quality of command decisions while reducing the number of staff members required to process and manage the information systems required to do so. The approach is to provide a very intuitive, well integrated, decision-centered, information environment in which the commander and a few staff members can quickly understand the changing battlefield situation, select the best course of action (COA), communicate that COA to the implementing units, and monitor the execution. The key technologies to be developed are: (1) an integrated visualization environment where the commander and his staff can view immediately understandable presentations of the changing battlefield situation, presentations which are tailored to the situation and the command decisions of interest; (2) a powerful and comprehensive human-computer interaction capability (through speech and gesture understanding, language understanding, dialog management, and visual collaboration) so that the commander and his staff can successfully understand and explore the information environment, without requiring dozens of staff members to operate and integrate multiple information systems; (3) a command post dialog manager which would automatically track current activities and tasks in the command post to tailor the information presentations to topics of interest; (4) an integrated suite of knowledge bases, intelligent agents, plan sentinels, information processing assistants which would automate many of the lower level staff functions and automatically invoke and operate supporting, planning and analysis applications; and (5) a modular, portable suite of hardware and software components that can be quickly configured and tailored to various command environments (stationary and mobile), at different echelons of command.

(U)   **Program Accomplishments and Plans:**

(U)   FY 1997 Accomplishments:

• Dynamic Multi-User Information Fusion (DMIF) program: Achieved significant milestones in developing and demonstrating, with Service transition partners, strategically controlled fusion processes and services for providing tailored situation representations which facilitate technology insertions and functionality through a broad spectrum of operating environments. Initiated the construction of a simulated test environment for early assessment of user requirements and operational concepts, for performance evaluations and validation of fusion engines, and for easy integration with other developmental and Service information systems. Integrated DMIF technology into All Source Analysis System (ASAS) and continued the insertion of DMIF capabilities into the Electronic Systems Command (ESC), Air Intelligence Agency (AIA), and Combined Air

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Operation Center (CAOC) in Vicenza, Italy. Demonstrated a prototype stand alone, multi-source, inference-based fusion system for a limited target set at multiple sites, including over distributed networks. DMIF migrated that system toward an open, agile, and robust architecture to promote interoperation with existing operations/intelligence battlefield information systems. ($17.8M)

- Battlefield Awareness and Data Dissemination (BADD) ACTD: BADD participated in and was successfully evaluated in Task Force XXI Army Warfighting Experiment. BADD also demonstrated system capabilities in a series of demonstrations, including a joint demonstration (called the Joint Forces Integration Demonstration) involving Navy, Marine and Air Force elements. Capabilities and services evaluated included: Information Dissemination Server located in Washington, DC; Tactical Information Dissemination Servers in use by the Army at Fort Irwin; leased Global Broadcast System (GBS) commercial satellite communications interfaces; creation and dissemination of an operational picture of red and blue force status; and dissemination of integrated imagery, video, signals intelligence, terrain, weather, Global Command and Control System (GCCS) and Maneuver Control System (MCS) data. In addition, BADD participated in and demonstrated enhanced functionality in various demonstrations (Systems Integration Laboratory, JWID 97, and in Korea/PACOM [Focused Intel]) conducted by the Phase II system integration contractor. Efforts were made to enhance legacy systems focused on improving bandwidth utilization and expanding the user base to include additional major military commands. Efforts during this fiscal year culminated in the delivery of an operational capability supporting CONUS based users and enhancements to the current capability supporting OCONUS users. ($28.9M)

- Airborne Communications Node (ACN): Initiated technology development of advanced digital receiver, RF MEMS tunable filters, EMI mitigation devices, and ultra-wideband/wideband antennas. These technologies will enable simultaneous operation across the frequency spectrum 20-2800 MHz. Initiated and completed four studies (executed by Service laboratories and FFRDCs) to identify baseline designs and risk areas: System Concept for the Communications Controller and Programmable RF Infrastructure for the ACN; ACN Design Development for the Antenna System/EMI Mitigation System; ACN Handheld Communication Services and Warfighter's Internet study. ($8.4M)

(U) FY 1998 Program:

- DMIF: Continuing development of the DMIF system to implement an architecture for strategically controlled fusion which performs real-time context-sensitive tasking of multiple fusion engines. This tasking adapts to the characteristics of available or incoming information, the performance of the available information processing applications (such as ASAS or GCCS), and the specific tactical situation (as represented by the commander's critical intelligence requirements or via automated planning systems). By selecting fusion engines and tuning their parameters based on the real-time context, strategic control of multiple fusion

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engines ensures that users get peak performance over a much broader range of conditions than any single fusion engine could provide. Systems being considered include fusion engines from the Army, Air Force, Navy, national agencies, and R&D systems. Complete the first in a series of Product Finishers, including those supporting precision targeting, and integrating with operations applications that require real-time focused situational awareness. Demonstrate functionality at integrated operations/intelligence demonstrations with the JFACC program, the DARPA-DISA Joint Program Office, and potentially XVIII Airborne Corps, and transitioning components into ASAS. ($11.9M)

- Dynamic Database (DDB) Program: Complete the Phase I DDB architecture design. Install the DDB Testbed to facilitate the exchange and evaluation of ideas and approaches, support distributed experimentation requirements, incubate and integrate evolving DDB technologies, and conduct system and technology proof-of-concept demonstrations. Lay the foundation for future DDB development by integrating existing "backbone" products (such as algorithms, phenomenology models, software, and databases) into the DDB Testbed. In conjunction with DMIF, produce an initial object schema for the Dynamic Situation Model. Initiate single and multi-sensor fusion algorithm research and demonstrate a prototype update service for the sensor history layer of the Dynamic Database. Produce initial geo-registration and mosaicing tools for SAR, MTI, IR, and ELINT sensor and incorporate tools in the Dynamic Database computation services. Develop a limited spatio-temporal database query capability. Produce an application programming interface specification for the Dynamic Database management system. Incorporate the initial Dynamic Situation Model object schema into the Dynamic Database and demonstrate the ability to ingest and process raw sensor data. Collect SAR, MTI, IR, and ELINT sensor data in preparation for FY 1999 activities. ($16.0M)

- BADD ACTD: BADD is participating in and is being formally evaluated in an ACOM-conducted evaluation of the information dissemination management (IDM) programs first software release, increasing the level of automation previously provided to users and extending information management and dissemination support to the level of individual battalions/ships. BADD is providing new information management capabilities to include creation of a 3D graphical depiction of a consistent operational picture by near-real-time integration of all relevant databases, and identification and semi-automated resolution of differences building on DMIF technology. BADD is also standing up the first digital tactical video server and demonstrating real-time population of that server, as well as automated meta-data generation for a number of tactical video surveillance platforms. BADD is creating a CONUS Pilot Service for ACOM components and demonstrating and delivering an OCONUS Pilot Service tailored for the Pacific theater supporting the IDM program at DISA and the GBS Joint Program Office. In addition, BADD is contributing advanced information and communications management services to the information management architecture being created to support the launch of UFO-8 by the GBS Program Office. ($43.7M)

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- Airborne Communications Node (ACN): Conduct and complete ACN System Design and Technology Integration study. Continue Advanced Digital Receiver and RF MEMS Tunable Filters technology efforts and initiate efforts in programmable INFOSEC, advanced digital transmitter/external power amplifier and time varying magnetic flux antenna. Initiate core technology integration and conduct initial technology demonstrations. The Warfighter's Internet Program has been integrated with the ACN Program and all reference to WI subsequent to FY 1999 will be under the ACN Program. ($11.1M)

- Command Post of the Future: The program will focus on defining the operational concept for the new system and developing a concept demonstration to show operational users for evaluation and feedback. Some components of the system prototype will be simulated during this development cycle. Program management activities will include refinement metrics of success and identification of key milestones. The development of an experimental prototype and demonstration will emphasize three activities: generation of an operationally realistic scenario with storyboards, assessment of technologies suitable for realizing the system vision, and integration of a set of technologies in the form of a testbed which can be used for early experimentation. The technologies to be incorporated in the FY 1998 prototype include selected operational C4I/simulation systems that can support the scenario. Emerging technologies expected to be incorporated include electronic sand & map tables and large format displays, speech and gesture interface, and dialogue management software will be developed to support human interface experiments. In addition, collaboration, workflow management, agent and sentinel technologies will serve key roles in the prototype. ($3.2M)

(U) FY 1999 Program:

- Continue the development of DMIF functionality. New capabilities will include moving from static to dynamic strategic fusion control in order to react, in real time, to new information requirements from users; and moving from pre-loaded to "agile" information models in order to incorporate, in battle-relevant timeframes, new knowledge about enemy forces and tactics. The program will also add to the number of fusion engines (at least twelve systems) that are strategically controlled by DMIF, thereby both improving the performance of the confederated fusion engines and extending the interoperability of all systems which are associated with the encapsulated fusion engines. Add to the series of Product Finishers, including those supporting SEAD, maneuver control, and IPB. Integrate selected DMIF services into broader environments that require entity-level fusion, specifically the Dynamic Database, GCCS, ASAS, and AITS, to create a product line of fusion systems that work flexibly and seamlessly with existing and emerging battlefield information systems. ($8.0M)

- Complete a Phase II DDB architecture design that integrates DDB and DMIF technologies. Expand the Dynamic Situation Model object schema to include pedigrees that map force-level situation assessments to multi-sensor source data. Develop and validate single-sensor terrain and entity phenomenology models.

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Develop prototype multi-sensor target phenomenology models. Elicit and incorporate situation context into single and multi-sensor anomaly detection algorithms. Demonstrate a prototype update service for the entity layer of the Dynamic Database. Extend database query services to include limited content-based index and query capabilities. Leverage existing COTS/GOTS technology to develop interactive tools for manipulating and visualizing Dynamic Database contents. Integrate technology products in the DDB Testbed and demonstrate a prototype DDB system that ingests raw multi-sensor data, aligns and mosaics the data within a common spatio-temporal reference frame, identifies and cues the user to uncorrelated data features, updates the sensor history layer of the Dynamic Situation Model, and provides the user ready access to sensor history data. ($30.0M)

- BADD ACTD: Begin the 2-year ACTD sustainment phase. Continue developing technology enhancements and system capabilities as part of a technology improvement program separate from the ACTD. Examples of increased information management functionality include the creation and dissemination of the consistent operational picture by near-real-time integration of all relevant databases, and identification and automated management of differences using DMIF and DDB technology. Provide capabilities to perform resource management of multiple communication paths. Evaluate this capability via participation in a joint demonstration using Airborne Communications Node (ACN) technologies. Operate Pilot Services and complete transition of initial CONUS and OCONUS Pilot Services. Enhance the capability to ingest theater sensor data streams, add value by exploitation, and disseminate the raw and enhanced data stream via GBS thereby avoiding the need for many ground sites within line of sight of sensor platforms. BADD will begin investigating advanced technologies for extending information management services to support real-time mission-critical and life-critical applications and will pursue advanced models and tools for enabling commanders to create operations-based information management policies. ($47.9M)

- Airborne Communications Node (ACN): Complete Advanced Digital Receiver technology development and integration. Continue RF MEMS Tunable Filter, programmable INFOSEC, advanced digital transmitter/external power amplifier and antenna technology developments. Continue ACN technology integration and demonstration. Select multiple system design teams and initiate payload design and development. ($21.0M)

- Command Post of the Future: The program will expand on the design and initial development of the experimental prototype from the proof of concept in 1998. The systems architecture will be refined. Components that were portrayed in simulation will be implemented in initial systems versions, and selected components from the integrated visualization environment, human computer interface manager, dialog manager, battlespace reasoning manager, and network operations and communications manager will be developed and integrated. Working closely with military operational units, system experiments within an expanded scenario will be carried out, using an iterative development approach to converge software and hardware design.

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(U) The development of these technologies will be in conjunction with operational units from the USMC and US Army and evaluated in simulated joint exercises. ($12.0M)

(U) **Program Change Summary:**

	(In Millions)	FY 1997	FY 1998	FY 1999
President's Budget		67.9	96.4	105.5
Appropriated		61.7	89.4	N/A
Current Budget		55.4	85.9	118.9

(U) **Change Summary Explanation:**

FY 1997 Reflects repricing and rephasing of programs and reprogramming for SBIR program.
FY 1998 Reflects rephasing of BADD ACTD.
FY 1999 Increase reflects expansion of Command Post of the Future Program following initial study in FY 1998.

(U) **Other Program Funding Summary Cost:** N/A

(U) **Schedule Profile:**

Plan   Milestones
Feb 98 Deliver BADD products for IDM EOC1 Capability.
Apr 98 Demonstrate BADD capability (JTFX 98-1).
Apr 98 ACN Core Technology Initial Design Review.
May 98 Demonstrate DDB prototype in conjunction with Agency testbed.
Jun 98 Complete integration and lab demo of DMIF II and demonstrate interoperability with JFACC.
Jun 98 ACN Core Technology Final Design Review.
May 98 Complete ACN System Design/Technology Integration Study.
Jul 98 Deliver BADD battlefield awareness products for IDM EOC2.
Jul 98 Support operational exercise OCONUS (PACOM/Korea) and CONUS upgrade for BADD.
Aug 98 Complete ACN Advanced Digital Receiver Brassboard and test with ACN Testbed.
Sep 98 Complete prototype design of the Command Post of the Future.
Sep 98 Deliver BADD pilot service to OCONUS with DMIF baseline capability.

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Oct 98   Complete ACN reprogrammable INFOSEC design.

Oct 98   DDB Phase I design complete; DDB Testbed installation complete; specification for sensory history database complete.

Sep 99   Use Dynamic Situation Model from DDB for change detection and situation awareness laboratory demonstration with SAIP and DMIF.

Jun 99   Demonstrate single node prototype DDB sensor history database and computation services (registration and mosaicing) for SAR, IR, ELINT, and MTI.

Jun 99   Complete multiple ACN System Design Team awards.

Feb 99   DMIF demonstration of focused situation awareness in joint-level simulation with JFACC, service and Agency migration systems (ASAS, GCCS, STBMCS).

Aug 99   Integration of ACN core technologies and functionality demonstration.

Sep 99   Demonstrate technology enhancements to BADD capability (JWID '99).

Apr 00   Complete Integration and Demonstration of ACN core technologies.

Apr 00   Complete initial ACN System Design Reviews and downselect to one or two teams.

Aug 00   Complete DMIF transition to DISA, the Services, and DDB.

Sep 00   Complete BADD ACTD transition to DISA, GBS Joint Program Office (JPO) and the Services.

Sep 00   Demonstrate technology enhancements to BADD capability (JWID '00).

Sep 00   Complete ACN RF MEMS Tunable Filters upgrades.

Sep 00   Complete final ACN System Design Review(s) and downselect to a single team to develop and integrate the ACN payload.

Aug 01   Complete ACN Payload Integration and Bench Test.

Mar 02   Complete ACN Payload Integration and Test with Global Hawk.

Aug 02   Complete ACN Field Demonstrations.

Sep 02   Complete ACN Transition.

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COST (In Thousands)	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Communication and Simulation Technology	**124,961**	**74,212**	**56,114**	**29,750**	**31,049**	**32,549**	**36,549**	**Continuing**	**Continuing**
Advanced Simulation CST-01	40,507	30,142	26,698	0	0	0	0	0	N/A
Global Grid Communications CST-02	50,995	41,302	27,916	28,250	29,549	32,549	36,549	Continuing	Continuing
Defense Simulation Internet CST-03	33,459	2,768	1,500	1,500	1,500	0	0	0	N/A

(U) **Mission Description:** This program element is budgeted in the Advanced Technology Development Budget Activity because it's purpose is to demonstrate and evaluate advanced simulation and networking technologies that will seamlessly integrate command and control functions needed for future global defense operations.

(U) The Advanced Simulation project is developing advanced simulation technologies that provide seamless synthetic battlespace that will enable high fidelity simulation across a full range of DoD functions. As technologies mature, they are integrated, tested and demonstrated in excercise/demonstrations of varying size and complexity. Within this project, the Synthetic Theater of War (STOW) Advanced Concept Technology Demonstration (ACTD) program is developing advanced simulation technologies to provide a seamless synthetic battlespace to support joint training and mission rehearsal activities.

(U) The Global Grid Communications project is developing and demonstrating advanced networking technologies needed for global defense operations in the 21st century. Network services will be developed in order to support geographically dispersed staff for crisis management and to support warfighters in rapid deployment, highly mobile scenarios. The program requires the design, adaptation and development of new internetwork protocols. The three main efforts in this project are: (1) the Joint Task Force Advanced Technology Demonstration (JTF-ATD) of a rapid Commander Joint Task Force (CJTF) crisis response capability for a range of situations from multiple regional conflicts (MRCs) to operations other than war (OOTW) capable of being established and operational in days; (2) the Warfighter's Internet program which will develop and demonstrate a mobile wireless backbone communications network consisting of multiple airborne nodes which in turn connect to users and networks on the ground, on the ocean, and in

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the air, and (3) the Broadband Information Technology (BIT) program which seeks to develop all-optical multiple wavelength transmission and networking technologies.

(U)   The goal of the Defense Simulation Internet (DSI) program is to research, develop and test at scale (worldwide), a network infrastructure capable of enabling distributed, real-time, multi-media (video, voice, shared data and work spaces) simulation that will seamlessly integrate all simulation, modeling, command and control functions from early design to battle rehearsal enroute to the conflict. The DSI is continuing the transition to the Defense Information Systems Agency (DISA) Defense Information System Network (DISN) to be operational on a fully reimbursable basis.

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COST *(In Millions)*	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Advanced Simulation CST-01	40,507	30,142	26,698	0	0	0	0	0	N/A

(U) **Mission Description**: The strategic environment in which the United States operates will require Joint Forces to operate across the full spectrum of conflict. At the same time, resources will continue to shrink, requiring the Department to search for the most cost effective means to perform the full spectrum of defense functions. To support the National Military Strategy, the Advanced Distributed Simulation (ADS) program is developing advanced simulation technologies that provide seamless synthetic battlespace that will enable high fidelity simulation for Joint/Service readiness training and mission rehearsal. As technologies mature, they are integrated, tested and demonstrated in exercises/demonstrations of varying size and complexity. Within the ADS Programs the Synthetic Theater of War (STOW) Advanced Concept Technology Demonstration (ACTD) program is developing advanced simulation technologies that provide a seamless synthetic battlespace to support joint training and mission rehearsal activities. STOW applied high fidelity, platform level simulation technologies across the full spectrum of conflict enabling evolutionary changes in how joint forces train and rehearse for operational missions. The ultimate goal is to develop mature simulation technologies capable of representing Joint Forces from the level of Operations Other Than War (OOTW) up to the Joint Task Force level of combat. Specific technology efforts being undertaken as part of STOW include 1) Multiple simulation system interfaces to real world C4I systems; 2) Advanced Distributed Networking; 3) Initiation of DoD's High Level Architecture (HLA) within the simulation; 4) Advanced synthetic forces and environmental databases and; 5) Interoperability with the United Kingdom Synthetic Environment Program. These technologies are then transitioned to Service and joint simulation developers.

(U) The STOW ACTD technology development includes: Synthetic Environment, Synthetic Forces, Systems Design and Integration and Advanced Network components. The Synthetic Environment component concentrates on the creation of large scale digital environments including representation of dynamic terrain and targets, weather and environmental phenomena, as well as seasonal and diurnal variations. The Synthetic Forces component creates a scaleable, computer-generated joint military force that is both representative and behaviorally credible. This platform based simulation includes models of command forces as well as intelligence sensors and their related platforms. The high fidelity of the computer generated forces provides the capability to resolve battle outcomes at the weapon system level of detail. The System Design and Integration component develops the overall DoD High Level Architecture (HLA)/Run Time Infrastructure (RTI) compliant system design, interfaces to C4I systems, distributed exercise management, data collection and after action review applications.

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This architecture supports the requirements to initialize, manage, and analyze large scale distributed joint and combined exercises. The Advanced Networks component develops and integrates networking technologies necessary to support large scale distributed exercises. DARPA will transition network products, documentation and lessons learned to the Defense Information System Agency (DISA) to facilitate the efficient and cost effective utilization of evolving network infrastructures.

(U)   The STOW prototype supported the United States Atlantic Command (USACOM) JTF level exercise, Unified Endeavor 98-1 in October 1997, and will support subsequent USACOM exercises during FY 1998 and FY 1999. Operational experience in these large scale joint exercises provides valuable lessons learned, documentation, software products and tools/applications to support DoD's emerging family of Joint Simulation Systems, e.g. JSIMS, WARSIM, NASM, JSIMS Maritime component.

(U)   The existing Operational Simulation (OPSIM) Technology Program has been divided into two programs. The Advanced Simulation Technology Thrust (ASTT) builds on the STOW Program and develops advanced simulation technology supporting the next generation of DoD simulation systems. The goal of the ASTT program is to solve core simulation technology issues such as advanced synthetic environments modeling, multi-resolution modeling, and scaling. The ASTT program acts as a technology bridge to future DoD simulation developments such as the Joint Simulation System (JSIMS). The other element of the OPSIM program called Course of Action Analysis, integrates Advanced Distributed simulation and ASTT developed technologies into operational planning systems to provide course of action analysis for operational users.

(U)   **Program Accomplishments and Plans:**

(U)   FY 1997 Accomplishments:

* Developed an interactive synthetic terrain database (500 x 700 km) which supports an environmentally realistic joint battlespace. This included the continued development of environmental technologies such as interactive terrain and hydrology, integration of real weather conditions, battlefield obscurants and diurnal effects. Developed technology for simulating the full range of dynamic terrain and multi-state objects, e.g. cratering, damaged buildings, fighting positions, etc. ($6.0M)

* Developed and transitioned a broad range of joint synthetic forces representing combat elements and command and control structures from all of the Services. Integrated a distributed command and control structure portraying, in simulation, the influence of one command level on the actions of subordinate synthetic units.

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- Developed and integrated the interfaces to allow simulation to interact directly with existing military service C4I systems. ($15.0M)

- Demonstrated the prototype Synthetic Theater of War simulation with a seamless land/sea/air warfighting synthetic environment capable of representing a Joint Task Force (US-UK). Integrated, tested and expanded HLA compliant network technologies and network security devices. Integrated initial versions of the DMSO-DARPA Run-Time Infrastructure. Developed and integrated a HLA compliant data collection and analysis component to support After Action Reviews and analysis. Designed and tested an advanced distributed, secure, ATM based wide area network to support large scale joint exercises. Began the transition of STOW technologies, applications and tools, documentation and lessons learned to emerging joint and Service managed simulation programs, e.g. JSIMS, WARSIM and other Service simulations. ($12.9M)

- Developed advanced simulation technologies, beyond the scope of the STOW ACTD, supporting next generation simulation systems. Technology efforts include: Multi-fidelity synthetic environments and multi-resolution modeling of synthetic forces, adaptive behaviors and rapid behavior development for synthetic forces, scaleability to 20K platform objects in real time, improved synthetic environments network performance, and data collection techniques for use in a multi-cast environment. ($4.7M)

- Developed and demonstrated a prototype simulation capability to support rapid course-of-action analysis for a single service planning system, using automated, faster than real time (FTRT) battle simulation, with both friendly forces and reactive OPFOR to enable rapid review of courses of action developed as part of operational mission planning. ($1.9M)

(U) FY 1998 Program:

- Based on lessons learned from Unified Endeavor 98-1 and USACOM revised operational requirements, improve the STOW prototype and provide operational demonstrations of an increased capability to the joint warfighter in support of USACOM and the services. This includes enhancing the warfighter's capabilities to employ high fidelity, platform level simulations for a variety of missions, by improving technology, tools and applications. Integrate new/improved synthetic environments, synthetic forces, and networking technologies as well as products developed in conjunction with the United Kingdom's Synthetic Environment Program. Continue transition of STOW technologies to JSIMS and other DoD users. ($13.3M)

- Continue development of Advanced Simulation Technologies in the ASTT program to support JSIMS, WARSIM and other service simulations. Technology efforts include: Adaptive multi-skilled Synthetic Forces; scaleability to greater than 20,000 objects; distributed multi-cast data collection on large amounts of data; rapid generation of computer generated forces and alternative methods of Synthetic Force generation;

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single synthetic environments database abstraction to accommodate multiple simulation requirements; initial multi-resolution modeling techniques. ($11.9M)

- Continue to develop and demonstrate Course of Action Analysis (COAA) technology based on advanced simulation technology and related modeling techniques. Extend FY 1997 effort to provide a tightly coupled COA development/COA analysis environment that shortens the overall planning cycle by 50%. Evaluate: extension of COA technology to other Services; next generation COAA analysis techniques (such as advanced adversarial reasoning); and, the techniques necessary to tightly integrate the mission planning/mission rehearsal/mission execution monitoring end-to-end process as it applies to land combat. ($4.9M)

(U) FY 1999 Program:

- Continue to refine and demonstrate prototype technologies in support of USACOM and the services. Demonstrations will focus on the representation of a seamless land/sea/air warfighting synthetic environment with an ever increasing degree of realism, and C2 interfaces, to support Service and joint operational training and analyses while retaining the arbitration of battle outcomes at the platform level of resolution. Transition of technology, tools and applications will continue in support of the next generation of DoD simulations. ($13.8M)

- Continue to develop high risk Advanced Simulation Technologies required by, and in coordination with, JSIMS and other Service simulations (e.g. WARSIM) to meet their respective Full Operational Capability (FOC) requirements. Technology efforts will include: demonstrating advanced time management and filtering techniques required to support JTF level exercise; reducing the cost of generating realistic behaviors capable of goal-based reasoning for synthetic command entities; demonstrating advanced techniques capable of creating and maintaining a consistent environment that supports correlated operation of force-on-force simulation at multiple levels of resolution. Continue to transition all technologies to JSIMS, et al. ($12.9M)

(U) **Program Change Summary:**   *(In Millions)*

	FY 1997	FY 1998	FY 1999
President's Budget	47.3	28.5	26.7
Appropriated	39.6	27.2	N/A
Current Budget	40.5	30.1	26.7

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(U)   **Change   Summary   Explanation**:

FY 1997   Reflects minor realignment of STOW simulation project and reprogramming to SBIR program.
FY 1998   Reflects repricing of Course of Action Analysis (COAA) prototype.

(U)   **Other Program Funding Summary Cost**:   N/A

(U)   **Schedule Profile**:

Plan   Milestones
Mar 98   Demonstrate the ability of battalion level Synthetic Command Forces to plan a course of action,
          replan/respond to unexpected OPFOR tactics.
May 98   Support USACOM mission objectives in future exercises. Integrate and evaluate technologies developed
          under the United Kingdom's Synthetic Environments program. Utilize the STOW prototype to support the
          operational evaluation of technologies developed under the ACTD, ASTT and JSIMS programs.
Sep 98   Demonstrate ability for ADS network to support real-time transport of a .3 Gigabyte at 3k transactions
          per second.
Sep 98   Demonstrate the ability of STOW to support the Information Superiority Demonstration (ISD) 98.
Sep 99   Complete the development, integration and documentation of the STOW prototype. Complete final
          transition of STOW Technology to JSIMS/WARSIM/NASM/JSIMS MARITIME.
Sep 99   Transition ASTT simulation technologies to the JSIMS and the Service simulation developments.
Sep 99   Program completion and close out.

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COST (In Thousands)	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Global Grid Communications CST-02	50,995	41,302	27,916	28,250	29,549	32,549	36,549	Continuing	Continuing

(U) **Mission Description:** This project develops and demonstrates advanced networking technologies needed for global defense operations in the 21st century. Network services will be developed in order to support geographically dispersed staff for crisis management and to support warfighters in rapid deployment, highly mobile scenarios. The program will demonstrate that information technologies can be integrated with both advanced optical, high performance networks and mobile, wireless tactical. This will provide multimedia information flows, efficient use of bandwidth, and minimal logistical requirements for warfighting, disaster relief, emergency medical support. The program requires the design, adaptation and development of new internetwork protocols.

(U) The goals of the Joint Task Force Advanced Technology Demonstration (JTF ATD) include development of a rapid Commander Joint Task Force (CJTF) crisis response capability for a range of situations from multiple regional conflicts (MRCs) to operations other than war (OOTW) capable of being established and operational in days; provide collaborative planning tools to enable the development of integrated, executable operations plans in hours; provide enroute planning and execution management for the JTF staff; provide a software reference architecture that provides access to the defense information infrastructure (DII), links the national command authority (NCA), commander in chief (CINC), JTF and the components, and enables rapid tailoring of the operational environment; provide common servers and an application suite; and migrate the capability to the DII.

(U) The goal of a Warfighter's Internet is to expand open architecture and internetworking technologies into the mobile wireless domain to: provide a robust, automatically reconfigurable, internetworking capability; and, to support warfighters in rapid deployment and highly mobile scenarios. This will be accomplished as a joint effort with the Airborne Communications Node program and will enable a backbone communications network consisting of multiple airborne nodes which in turn connect to users and networks on the ground, on the ocean, and in the air. Provision for multimedia information flows, efficient use of bandwidth, and minimal logistical requirements are key objectives that require the design, adaptation and development of new network protocols for mobile, wireless battlefield networks. Technology development and demonstration will focus on networking technologies to integrate across existing and developmental communication systems and networks using airborne nodes such as Global Hawk (Airborne Communications Node). A scalable internet will be demonstrated in conjunction with joint service exercises and advanced warfighting experiments.

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RDT&E, Defensewide BA 3 Advanced Technology Development	Communication and Simulation Technology, PE 0603761E, Project CST-02

(U)   The Broadband Information Technology (BIT) program seeks to develop the all-optical multiple wavelength transmission and networking technologies. Specifically, this program has four goals: (1) a billion bit per second bandwidth on demand, independent of the analog and digital nature of the applications, (2) rapid, nearly transparent reconfiguration of network routing, (3) multiplexing of continuous transmission rates (bit rates from thousands of bit per second to billion of bits per second), and (4) transmission of analog and digital signals in a single fiber.

(U)   **Program Accomplishments and Plans:**

(U)   FY 1997 Accomplishments:

- Identified control and protocol issues for operation of multi-wavelength networks. ($4.1M)
- Demonstrated advance integrated optoelectronic network component operations.   ($9.0M)
- Completed multi-wavelength network architecture and control planning; and initiated field-trial network deployment for long-distance and wide area applications.   ($13.2M)
- Demonstrated integration with advanced virtual testbeds, increased number of JTF ATD servers, tools and applications available to the warfighter, expanded use of additional Object Oriented and advanced Web technologies, initiated development of scenario interpreters, multi-threaded services, bandwidth adaptive servers, and context based resource switching.   Transitioned selected components to the DII COE via the Advanced Information Technology Services (AITS) Joint Program Office (JPO). ($16.9M)
- Demonstrated a disaster relief and emergency medical services system that will provide real-time multi-media patient data (vital signs, EKG, images) from an accident scene and from enroute vehicles to Emergency Department physicians. Demonstrated enhanced command and control of emergency medical responders by providing real time location of assets and by providing best routing algorithms for quickest path to and from the accident scene. ($7.8M)

(U)   FY 1998 Program:

- Demonstrate multi-wavelength network management and control in local area testbeds. ($6.5M)
- Demonstrate 40 billion bit per second cross-connect switching and 32 channel transceiver chip.   ($10.0M)
- Continue analysis and report on economics of multi-wavelength network architecture and technology for local area optical networks. ($1.3M)
- Continue integration with advanced information technology services needed to extend the Joint Task Force (JTF) Infrastructure by providing "composable Advanced Information Technology (AIT) services" that will support the planning phase, the execution phase, and the dynamic replanning phase. Develop Java-compatible Object Web Tools for generic plan editing, and demonstrate persistent brief development tools, bandwidth

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- adaptive object based distribution and sharing, and schema unified semantic interoperability of several applications. Support the extension of the infrastructure, architecture, servers and applications across computing platform classes and to emerging and related programs within the DARPA C2 development environment with the "composable AIT services". Transition additional components to the current DII COE version via the AITS JPO. ($17.7M)

- Initiate and complete design and development of first phase of mobile, wireless network software and protocols, self-organizing cross links, network and mobility management, security, application interfaces, signalling protocols and RF subsystem integration and engineering based on the DARPA-led, joint Service study that defined technical requirements and network systems architecture for a Warfighter's Internet/joint tactical internetwork. Integrate technology with the Airborne Communications Node payload. ($5.8M)

(U) FY 1999 Program:

- Demonstrate full operations, multi-wavelength, experimental, system network including interoperability among testbeds distributed across several geographic domains. ($6.9M)

- Develop software applications and servers from the "composable AIT services", and expand the JTF reference architecture to include execution and dynamic replanning. Transition selected "composable AIT services" to the AITS JPO for future incorporation into the DII COE. Demonstrate rapid development of specialized plan viewers for multiple echelons. Develop distributed information logistics services for optimization of time-value of information delivery. Support the extension of the infrastructure, architecture, servers and applications across computing platform classes and to emerging and related programs within the DARPA C2 development environment using the "composable AIT services" model. Transition additional components to the current DII COE version via the AITS JPO. ($6.0M)

- In coordination with Airborne Communications Node, initiate development of second phase of airborne cross links, wireless backbone using manned aircraft/airborne platform; continue to develop network protocols and integrate into commercial products; integrate legacy and emerging radios in mobile, wireless internet. Demonstrate a 20X increase in bandwidth for the warfighter in Urban Warrior, Advanced Warfighting Experiment. ($15.0M)

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(U) **Program Change Summary:** *(In Millions)*

	FY 1997	FY 1998	FY 1999
President's Budget	42.0	44.6	43.9
Appropriated	49.0	43.1	N/A
Current Budget	51.0	41.3	27.9

(U) **Change Summary Explanation:**

FY 1997 Increase reflects repricing of the demonstrations portion of the JTF-ATD.
FY 1998 Decrease reflects rephasing of Warfighter's Internet.
FY 1999 Decrease reflects rebaselining of the JTF program, which is transitioning to the Services.

(U) **Other Program Funding Summary Cost:** N/A

(U) **Schedule Profile:**

Planned Milestones
3Q FY98 Complete large-area demonstration of optical network and advanced network management.
4Q FY98 Demonstrate initial execution and dynamic replanning functionality based on "composable AIT services".
4Q FY98 Complete first phase of the design and development of components for the mobile wireless network.
3Q FY99 Complete second phase of joint tactical internetwork, network hardware and software demonstrated on multiple airborne and terrestrial platforms.
3Q FY99 Demonstrate 20 gigabit per second, multi-channel, multi-media, large-area network.
4Q FY99 Demonstrate advanced execution and dynamic replanning functionality and transition selected "composable AIT services" to AITS JPO.
4Q FY99 Field demonstration of Warfighter's Internet end to end architecture coordinated with BADD, Extended Littoral Battlespace (ELB) and Small Unit Operations advanced warfighting experiments.
4Q FY00 Field demonstration of Warfighter's Internet end-to-end architecture coordinated with Airborne Communications Node and with BADD, Extended Littoral Battlespace (ELB) and Small Unit Operations in advanced warfighting experiments.

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Communication and Simulation Technology,
PE 0603761E

COST (In Thousands)	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Defense Simulation Internet (DSI) CST-03	33,459	2,768	1,500	1,500	1,500	0	0	0	N/A

(U) **Mission Description:** The goal of the Defense Simulation Internet (DSI) program is to research, develop and test at scale (worldwide), a network infrastructure capable of enabling distributed, real-time, multi-media (video, voice, shared data and work spaces) simulation that will seamlessly integrate all simulation, modeling, command and control functions from early design to battle rehearsal enroute to the conflict. The DSI meets DoD security requirements by using a commercial-off-the-shelf (COTS) encryption device (INES). The communications needs of the distributed, real-time, multi-media modeling and simulation community cannot be met with any other available technology. Commercial vendors are pursuing some of the required technologies, but development is too slow and unfocused to accommodate the immediacy of the Department of Defense's simulation requirements. The DSI program provides focus for the commercial development of the technologies needed by the simulation community for distributed work environments worldwide. Over 100 nodes currently extend the DSI to each of the Services, most of the Commanders-in-Chief (CINCs), some of our allies and other Government affiliated sites. These locations constitute the network's user sites; they provide valuable feedback on the technologies and methodologies being pursued and critical capability for both ongoing and major modeling and simulation events. DSI provided real time infrastructure for the Synthetic Theater of War (STOW) 97.

(U) The DSI is continuing the transition to the Defense Information Systems Agency (DISA) Defense Information Systems Network (DISN) to be operational on a fully reimbursable basis. It will be jointly managed by DISA and DARPA through the Advanced Information Technology Systems Joint Program Office. The transition of the DSI into the DISN provides affordability through consolidation of the costs required to operate multiple networks while continuing to support modeling and simulation requirements.

(U) **Program Accomplishments and Plans:**

(U) FY 1997 Accomplishments:
- Provided network operations and user services. Operations include the 24 hours per day/7 days per week, network security, exercise/event planning, management and the 24 hours per day/7 days per week CSC Help Desk. Provided STOW Exercise support. ($9.5M)

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- Procured telecommunication circuits: International circuits (T3 backbone), CONUS Phase II Backbone (T3) Tail Circuits (T1), upgraded high use STOW sites to high capacity tail circuits. ($11.0M)

- Upgraded network: Completed deployment of service upgrade which provides ATM switches, end-to-end encryption and the edge devices to sites which require this upgraded capability (70 sites). Automated network management to provide real-time management of high speed high bandwidth requirements. Provided resource reservation at the application level. Completed migration of Defense Simulation Internet (DSI) network operations and maintenance to Defense Information Systems Network (DISN). ($10.5M)

- Transition management: Provided programmatic integration management and engineering support through the DARPA/DISA (Advanced Information Technology Systems (AITS)) Joint Program Office (ADJPO) to identify and evaluate advanced technology candidates, offer pilot services, and transition Leading Edge Services (LES) technology to DISA. ($2.5M)

(U) FY 1998 Program:
- Transition management: Provide programmatic integration management and engineering support through the DARPA/DISA Advanced Information Technology Systems (AITS) Joint Program Office (ADJPO) to identify and evaluate advanced technology candidates, offer pilot services, and transition LES technology to DISA. ($2.8M)

(U) FY 1999 Program:
- Transition management: Provide programmatic integration management and engineering support through the DARPA/DISA Advanced Information Technology Systems (AITS) Joint Program Office (ADJPO) to identify and evaluate advanced technology candidates, offer pilot services, and transition LES technology to DISA. ($1.5M)

(U) **Program Change Summary:**   (In Millions)

	FY 1997	FY 1998	FY 1999
President's Budget	39.7	2.9	1.5
Appropriated	38.9	2.8	N/A
Current Budget	33.5	2.8	1.5

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(U) **Change Summary Explanation:**

FY 1997 Reflects realignment for repricing in network and circuit costs and reprogramming for SBIR program.

(U) **Other Program Funding Summary Cost:** N/A

(U) **Schedule Profile:**

Plan   **Milestones**
Jan 98   Completed transition of LES technology to DISA.
Sep 98   Identify and evaluate advanced technology candidates to DISA.
Sep 99   Identify and evaluate advanced technology candidates to DISA.
Sep 00   Identify and evaluate advanced technology candidates to DISA.
Sep 01   Complete programmatic integration management and engineering support to ADJPO.

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APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide	Sensor and Guidance Technology,
BA 3 Advanced Technology Development	PE 0603762E, R-1 #52

COST (In Thousands)	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Sensor and Guidance Technology	**104,299**	**167,184**	**213,154**	**232,646**	**204,718**	**189,169**	**212,096**	**Continuing**	**Continuing**
Guidance Technology SGT-01	12,974	36,668	36,872	36,766	33,731	31,697	35,764	Continuing	Continuing
Aerospace Surveillance Technology SGT-02	1,471	19,603	70,500	89,500	91,500	46,500	48,500	Continuing	Continuing
Air Defense Initiative SGT-03	18,854	20,906	33,050	53,130	27,180	30,560	35,000	Continuing	Continuing
Sensors & Exploitation Systems SGT-04	71,000	90,007	72,732	53,250	52,307	80,412	92,832	Continuing	Continuing

(U) **Mission Description:** The Sensors and Guidance Technology program element is budgeted in the Advanced Technology Development Budget Activity because it is developing the system oriented technologies necessary to enhance sensor and weapon system accuracy and capability to meet current and emerging threats. Four projects are funded in this program element: Guidance Technology, Aerospace Surveillance Technology, the Air Defense Initiative, and Sensors and Exploitation Systems.

(U) The Guidance Technology project is leveraging geolocation technologies to enhance the navigation and/or guidance packages of airborne platforms, ground vehicles and weapons. These improved systems will improve the accuracy and effectiveness of stand-off weapons, minimizing collateral damage while reducing the cost-per-kill.

(U) Aerospace Surveillance Technologies programs are developing technologies to improve the accuracy and timeliness of surveillance systems in all weather, in hostile reception environments, and when necessary, in a covert manner. The six programs funded by this project exploit recent advances in multispectral target phenomenology, signal processing, high performance computing and micro-electronics technologies.

(U) The Air Defense Initiative is an on-going activity whose overall goal is to reduce the proliferating cruise missile threat and enhance the survivability of U.S. assets in the face of enemy electronic countermeasures.

(U) The objective of the Sensor and Exploitation Systems project is to provide the warrior with situational awareness and battlefield dominance by developing key sensor technologies; providing near-real-time exploitation of imagery data; and semi-automated target recognition and tracking.

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COST *(In Thousands)*	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Guidance Technology SGT-01	12,974	36,668	36,872	36,766	33,731	31,697	35,764	Continuing	Continuing

(U) **Mission Description:** Fire-and-forget stand-off weapons need precise targeting information if critical fixed and mobile targets are to be eliminated effectively with minimal collateral damage and minimum cost-per-kill. This requires that: (1) military surveillance and targeting systems geolocate targets accurately in the same coordinate system (i.e., WGS-84) in which the weapon system navigates; (2) the surveillance, targeting and weapon systems have precision navigation and guidance systems on-board; and (3) navigation and target location systems operate day/night and in adverse weather. In addition, future systems designed to accomplish precision strike missions must be significantly more affordable. The achievement of these characteristics in an integrated system is the goal of this program. The Global Positioning System (GPS) Guidance Package (GGP) technologies funded in this project are applicable for both new or retrofit guidance/navigation packages for a variety of airborne platforms, ground vehicles, surface-to-surface standoff weapons and air-to-surface weapons. Additional thrusts are also included in this project to increase the robustness of precision GPS navigation; to increase the versatility of navigation systems applications by developing micro-electromechanical sensor inertial navigation system technologies; and to apply the geolocation technologies/techniques to precision threat geolocation (Advanced Tactical Targeting Technology Program).

(U) GGP tightly integrates a miniature GPS receiver and an all solid state, low cost, navigation-grade, interferometric fiber optic gyroscope (IFOG) based miniature inertial measurement unit (MIMU) with an advanced navigation computer into a low cost ($15,000), precision navigation system. GGP Phase I addressed the technology issues involved in: (1) miniaturizing navigation grade inertial measurement units (IMUs) into a compact, manufacturable configuration; and (2) developing a multi-channel-on-chip, high dynamics GPS receiver. A Memorandum of Agreement (MOA) has been signed and implemented to demonstrate a Phase 1 unit on an Army Fire Support Team Vehicle (FIST-V). Successful demonstrations were conducted at Redstone Arsenal in June 1995 using a M981 FIST-V. Successful demonstrations also were conducted on an F/A-18. These tests assessed the performance of tightly coupled systems in high dynamics and validated Phase 1 design scenarios. GGP Phase 2 requirements place more stressing demands on performance of MIMU components and call for further reductions in size, power and weight. An MOA has been signed with the Navy designating GGP Phase 2 as the Navy's Advanced Integrated Navigation and Control Package. Another MOA was signed with the Program Executive Officer, Tactical Missiles, Army Missile Command. Potential applications

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include the Multiple Launch Rocket System. A third Memorandum of Agreement (MOA) is in coordination with the Program Executive Office, Ground Combat and Support Systems, Army Tank and Automotive Command. Potential application is the Bradley Fire Support Team Vehicle (BFIST-V).

(U) The Global Positioning Experiments (GPX) will improve GPS receiver robustness by increasing their ability to operate effectively in presence of enemy jamming or countermeasures. First, an all-in-view Miniature GPS Receiver (MGR) chipset will be upgraded to demonstrate precision GPS direct code acquisition by employing a multi-correlator, fast acquisition integrated circuit and high performance clock. Operation with precision P(Y) GPS code signals increases the MGRs robustness to jamming. The second thrust will provide for the design, development, implementation and demonstration of a low cost, all digitally controlled GPS adaptive phased array receiver antenna. This type of antenna eliminates the need for coherent precision matched analog antenna components and antenna recalibration for stressing military environments.

(U) The Micro-Electromechanical Sensor Inertial Navigation System (MEMS INS) program will improve the silicon based, inertial sensors (gyros and accelerometers) developed in the MEMS technology program and integrate them with navigation software into a low power, small, light weight, low cost, tactical grade (1.0 degree per hour to 10 degrees per hour drift rate) INS. In addition to handheld applications, the MEMS INS will be generic for insertion/embedding into other military systems. MEMS INS Phase 1 will perform the following: (1) select and improve appropriate MEMS inertial sensors, (2) select and refine foundries/foundry processes, (3) design the mechanical subsystem, and (4) select/refine the navigation software and perform INS simulations of the modeled sensors. Phase 2 will develop the MEMS inertial sensors brassboard, integrate them into a MEMS INS and demonstrate the brassboard in the field.

(U) The Advanced Tactical Targeting Technology (AT3) will demonstrate a passive tactical targeting system for the lethal suppression of enemy air defenses (SEAD). Today's threat radar targeting systems employed for SEAD fail to provide the rapid and accurate emitter geolocation needed to replace dedicated anti-radiation missiles (ARM) with generic, shoot-to-coordinate, smart weapons (e.g., JDAM or JSOW). The targeting system must negate emitter shutdown tactics now employed to defeat ARM guidance and enable simplified ordnance inventories. Generation and distribution or near real-time (e.g., seconds) comprehensive, and highly precise location of threat radars to all theater combatant aircraft is required without deploying any extra, SEAD dedicated, emitter collecting platforms. AT3 will accomplish this by widely deploying emitter collection packages hosted on existing airborne platforms, including combatant aircraft. AT3 will integrate (fuse) in real-time the distributed multi-platform emitter collections using existing or planned tactical (narrowband) radios with advanced network management (data packets) and signal

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processing. Additionally, to achieve the necessary wide deployment, AT3 self contained collection packages must impose negligible burden on their airborne hosts and be available at affordable prices. Enabling technologies now in development at DARPA will be used, including highly agile digital receivers packaged in multichip modules (MCMs), highly precise tactical clocks, tightly coupled integrated GPS/INS packages and advanced highly dynamic data fusion network management capabilities. Critical system advancements are (1) generating the commonly registered, theater-wide absolute doppler corrections to collected data and (2) managing the extraordinarily dynamic real-time data network including individual user kinematics and a changing aggregate participating user population.

(U)   The Autonomous Landing Guidance (ALG) Technology Reinvestment Project (TRP) follow-on operational assessment program will install and demonstrate a low-visibility, day-night, precision approach and landing capability that is compatible with Air Mobility Command (AMC) operational requirements. The program will leverage work accomplished under the DARPA ALG TRP. The system (94GHz radar, Forward Looking Infrared (FLIR), Head-Up Display (HUD)) developed under the ALG TRP will be installed in a USAF C-130H3.

(U)   **Program Accomplishments and Plans:**

(U)   FY 1997 Accomplishments:
- Completed GGP Phase 2 designs and began fabrication of GGP units.   ($9.8M)
- Completed evaluation of Phase 1 units on the Navy testbed aircraft.   ($.2M)
- Investigated and evaluated applications of the Miniature GPS Receiver (MGR) portion of the GGP for enemy air defense suppression.   ($1.0M)
- Identified micro-electromechanical sensor (MEMS) foundries and developed MEMS inertial navigation architecture(s).   ($1.5M)
- Coordinated Autonomous Landing Guidance (ALG) installation on operational C-130.   ($.5M)

(U)   FY 1998 Program:
- Continue fabrication and begin integration of GGP Phase 2 hardware and software.   ($6.0M)
- Design circuits and power management techniques for the direct precision GPS code, low power, robust MGR.   ($10.0M)
- Design the GPS adaptive antenna array, signal processing and control functions for the MGR.   ($8.9M)
- Demonstrate proof of concept MEMS devices.   ($3.3M)
- Conduct Advanced Tactical Targeting Technology (AT3) design and development.   ($7.8M)
- Complete ALG system installation on C-130H3, and conduct operational flight tests.   ($.7M)

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(U) **FY 1999 Program:**

- Perform final integration and testing of GGP units; deliver eight units. ($4.6M)
- Fabricate and demonstrate the robust MGR. ($5.6M)
- Conduct final design reviews and complete integration of adaptive GPS receiver antenna and signal processing. ($5.4M)
- Iterate MEMS foundry inertial sensor fabrication and initiate preliminary sensor testing. ($9.3M)
- Complete AT3 design and conduct critical component demonstrations. ($8.8M)
- Begin AT3 brassboard fabrication. ($3.2M)

(U) **Program Change Summary:** (In Millions)

	FY 1997	FY 1998	FY 1999
President's Budget	10.5	32.7	36.6
Appropriated	10.3	31.5	N/A
Current Budget	13.0	36.7	36.9

(U) **Change Summary Explanation:**

FY 1997 Increase reflects additional efforts in the evaluation of miniature guidance technologies, specifically for micro-electromechanical sensor (MEMS) inertial navigation technologies.
FY 1998 Change reflects increased emphasis on the integration of GGP with current platforms.
FY 1999 Changes reflect minor program repricing.

(U) **Other Program Funding Summary Cost:**

	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
PE 0305154D	1.1	0	0	0	0	0	0
PE 0305206D	N/A	1.5	1.4	1.0	1.0	1.0	1.0
PE 0603203F	0	0	0	3.0	5.3	0	0

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(U) **Schedule Profile:**

Plan	Milestones
Apr 98	Begin design of the Advanced Tactical Targeting Technology (AT3).
May 98	Begin integration of hardware and software for GGP Phase 2 units.
May 98	Complete fabrication of the direct P(Y) code, low power MGR breadboard.
Jun 98	Autonomous Landing Guidance (ALG) system installation on C-130H3 complete.
Sep 98	Conduct preliminary design review of MEMS gyro/accelerometer.
Sep 98	Complete preliminary design of the AT3.
Oct 98	Complete critical design reviews and begin fabrication of an adaptive GPS antenna array.
Nov 98	Demonstrate full function, low power miniature GPS receiver breadboard.
Jan 99	ALG C-130H3 flight test complete.
Jan 99	Deliver brassboard MEMS gyros.
Jun 99	Complete AT3 critical component demonstrations and begin brassboard fabrication.
Jun 99	Deliver GGP units to the Government.
Sep 99	Deliver engineering model MEMS accelerometers.
Sep 99	Complete integration of an adaptive GPS antenna array.
May 00	Complete integrated demonstration of miniature GPS receiver and adaptive antenna.
Jun 00	Complete AT3 brassboard fabrication and begin ground tests.
Sep 00	Test and deliver brassboard MEMS inertial navigation system.

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COST (In Thousands)	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Aerospace Surveillance Technologies SGT-02	1,471	19,603	70,500	89,500	91,500	46,500	48,500	Continuing	Continuing

(U) **Mission Description:** This project funds space and airborne sensor efforts that will improve the accuracy and timeliness of our surveillance systems for improved battlefield awareness. Timely surveillance of enemy territory under all weather conditions is critical to providing our forces with the tactical information needed to succeed in future wars. This operational surveillance capability must continue to perform during enemy efforts to deny and deceive the sensor systems, and operate, at times, in a covert manner. This project will exploit recent advances in multispectral target phenomenology, signal processing, large constellation satellite architectures, low-power high-performance computing, and low-cost micro-electronics to develop advanced surveillance systems.

(U) The Millimeter Wave Targeting & Imaging System (MMWTIS) program will develop and demonstrate a targeting and imaging, single UAV platform, all weather, day/night medium altitude capability at millimeter wave (W band) frequencies. This system will use active and passive techniques to achieve high resolution targeting (low CEP) and imaging (1-3 m). This system shall be used for weapons targeting, high resolution imagery, and battle damage assessment. Aperture sizes to be developed depend on developed active/passive system concepts (SAR/illuminator/passive radiometer) operating from tactical or MAE UAV operational altitudes. This program will pursue advanced radar algorithms and sparse aperture concepts, and intelligent incorporation of miniaturized monolithic integrated circuit (MMIC), advanced W band power amplifier technology, radio frequency photonics technology and low power high performance computing.

(U) The Passive Radar Tag for Covert Communications will provide a covert capability to remotely extract data from unattended ground sensors and Special Operation Forces (SOF) in real-time by airborne sensors such as the Joint Surveillance Target Attack Radar (JSTARS) or Advanced Synthetic Aperture Radar System (ASARS) surveillance radar systems. Miniature prototypes have been developed for other radars such as the APS-137 and APS-145 used on the E-2C and P-3. The tags will use special wake-up circuitry, surface acoustic wave delay lines, and modulation techniques to detect, delay, and modify radar pulses from these radars such that the return pulse received by the radar will include unique identification numbers and data messages from the tag. Covertness will be obtained by the choice of modulation and the amplitude of the returned signal. The interrogating radars will be modified to detect, identify, and display the tag message. Variants of the tag will be produced to be compatible with air delivered internetted ground sensors and with man portable tags used by Special Operation Forces (SOF) units. Low cost tags (<$300) will

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be developed for cost effective and covert, friendly situation awareness. Other variants will be used to precisely register synthetic aperture radar imagery and to enhance communications of geolocation and other data between widely dispersed operating units.

(U)   The Adaptive Spectral Reconnaissance Program will develop a new generation of airborne reconnaissance systems based on spectrally adaptive imaging sensors. Because it is particularly suited to real time detection processing, spectral technology will enhance the ability to conduct wide area search for high value targets from both manned and unmanned airborne platforms without substantially increasing demands on communications infrastructure or ground based data analysts. This program will, in conjunction with the Defense Airborne Reconnaissance Office, develop a day/night system using both reflected sunlight and thermal infrared emissions. This system will be demonstrated on both a manned platform and an Unmanned Air Vehicle (UAV) platform.

(U)   The Tactical Radar Program will develop a new generation of aerospace-based radars tailored to support theater military operations. The program's first goal is development of an aerospace-based Ground Moving Target Indicator (GMTI) capable of detecting mobile-missile launchers and other high value ground threats deep in denied territory, beyond line-of-sight of airborne air surveillance assets. This includes developing techniques to enable an aerospace-based radar to function in a mode of operation enabling simultaneous collection of both Synthetic Aperture Radar (SAR) imagery and GMTI data, at very high area rates, without performance degradation. The second goal is development of techniques to correlate discontinuous GMTI target tracks ($\geq$ 4 min track durations, with intervening gaps of $\leq$ 15 min) produced by aerospace-based radar. The third goal is development of techniques to exploit aerospace-based SAR imagery for near-real-time (NRT) derivation of high-precision geolocation estimates ($\leq$ 3 meter Total Location Error) for ground targets, using high-fidelity Digital Terrain Elevation Data (DTED Level-5) in conjunction with SAR imagery.

(U)   The Starlite program seeks to prototype a constellation of low earth orbit High Resolution-Ground Moving Target Indicator (HR-GMTI)/SAR radar surveillance satellites to provide timely, near continuous, hi-resolution, monitoring of any theatre, anytime, anywhere. To achieve such revisit rates will necessitate deploying a large (24 bird) constellation. That in turn will necessitate achieving a revolutionary reduction in satellite per-unit on-orbit costs ($75-$100M), if concept implementation is to be affordable. Therefore, in addition to attaining the tactical radar program's principal surveillance technical goals, other advances must be achieved before system development can be pursued with acceptable risk: 1) developing a low-cost, multi-mode (GMTI/SAR) space-qualified electronically scanned antenna, 2) developing low power Microelectromechanical Systems (MEMS) for scanning of radar modules and solar panels (10x reduced power requirement), and 3) sparse band processing for data compression allowing on-ground

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processing with .5Gbps links, and Automatic Target Recognition (ATR) quality (.5m) range profiling. The proposed satellite system will also use an interferometric synthetic aperature radar (FFSAR) capability to produce high-accuracy digital terrain elevation data (DTED) to support both battlefield visualization (BV) and precision guided munitions (PGM) targeting (3m localization accuracy theatre wide). Starlite is a joint effort with the National Reconnaissance Office (NRO) and U.S. Air Force. While FY 1999 is the first year of dedicated DARPA funding, elements of ongoing DARPA technology programs, particularly the Tactical Radar and Digital Terrain Mapping (Project TT-03) efforts, have direct relevance to the Starlite Program. In addition, a total of $18M has been provided in FY 1998 by the NRO and Air Force to initiate the program.

(U)   The Novel Antennas Program applies crossover technologies, leveraging major investments already made in photonics, antennas and space-time adaptive array processing with the latest advances in digital receivers and devices employing superconductivity, to produce small, light-weight systems with low power requirements that are capable of locating specific emitters in a dense interference environment.

(U)   The Large Millimeter Wave Telescope (LMT) is a Congressionally mandated program to develop the largest (50 meter aperture) fully steerable millimeter wave radio telescope built to date. The design features a sophisticated laser metrology system to maintain precise alignment of the optics, and real time closed loop adaptive control actuator system to maintain a near-perfect parabolic surface at all pointing angles and under most environmental conditions.

(U)   **Program Accomplishments and Plans:**

(U)   FY 1997 Accomplishments:

- Completed the design of the foundation, pedestal, pedestal bearing, radome and tilting structures and the mechanical drive and pointing systems of the Large Millimeter Wave Telescope program.   ($1.5M)

(U)   FY 1998 Program:

- Millimeter Wave Targeting & Imaging System (MMWTIS) - Initiate development of W band targeting system to include technology development and system design. Initiate trade studies and concept development by targeting compatible millimeter wave imaging designs (active/passive) and technology. Initiate millimeter wave target signature characterization as part of concept verification. Parameterize critical technology elements and begin technology risk reduction activities.   ($4.6M)

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- Passive Radio Frequency (RF) Tags for the Covert Communications program – Perform analyses for multiple concepts of operation to include remote communications of sensor data from unattended ground sensors, data communications from Special Operations Forces (SOF), geo-registration of Synthetic Aperture Radar (SAR)/Moving Target Indicator (MTI) imagery, and communications of geo-location and other data between dispersed operating units. System design for each operational concept will be conducted, and fabrication of brassboard RF tags, modifications to airborne SAR/MTI processors and ground stations will be completed. ($5.0M)

- Adaptive Spectral Reconnaissance program – Define system concept and sensor specification based on government and industry inputs. Demonstrate prototype system on a manned platform and verify system concept. Begin system development, including the spectral sensor component. ($3.0M)

- Tactical Radar Program – Develop initial algorighms supporting aerospace-based ground moving target indication (GMTI) using low-cost, light-weight, multiple phase center/receive channel antenna and 548 Mbps CDL. Establish feasibility of high-throughput, GMTI collection (>250 km2/sec collection rate, sustained over >6 min). Establish feasibility of achieving <10 kph Minimum Detectable Velocity (MDV) for ground targets. Develop initial algorithms supporting GMTI collection performance while simultaneously collecting undegraded synthetic aperature radar (SAR) phase history data, in 3m resolution mode. Establish feasibility of achieving discontinuous GMTI track correlation, and develop initial algorithms enabling GMTI target tracking. Conduct selective/limited GMTI data collection using existing airborne SAR platforms. ($4.1M)

- Continue development and testing of subsystem components of Large Millimeter Wave Telescope. ($2.9M)

(U) FY 1999 Program:

- Millimeter Wave Targeting & Imaging System (MMWTIS) – Continue development, conduct laboratory demonstrations, and initiate field testing of W band targeting system. Finalize compatible imaging system designs, issue RFP for, and begin integrated system development. Complete millimeter wave target signature characterization. Continue technology risk reduction activities. Develop concept of operations. ($15.5M)

- Passive Radio Frequency (RF) Tags for the Covert Communications program – Test multiple brass board RF Tags and the modified airborne Synthetic Aperture Radar (SAR) and Moving Target Indicator (MTI) radar systems. Ground and flight tests with several airborne platforms will be performed to validate performance. Design and fabrication of miniaturized tags will be performed and a test and evaluation plan developed. ($11.0M)

- Adaptive Spectral Reconnaissance program – Continue system development. Demonstrate prototype system in a range of operational scenarios. ($8.0M)

- Tactical Radar program – Use algorithm chain processor to demonstrate: 4kt MDV detection performance; high-throughput GMTI; GMTI target tracking capability; acceptable probability of detection/false alarm

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performance (.9Pd at track level with 4 min revisit); data based feasibility of simultaneous Ground Moving Target Indication/Synthetic Aperture Radar (GMTI/SAR) mode; ground moving target identification and characterization) Pclass of .95 vs .1 for JSTARS). Demonstrate ability to deconflict targets and track convoys using airborn collects, with 5-10 targets per cross range resolution cell. Demonstrate ability for real time automated track fusion of SAR and GMTI data to monitor targets birth to death including stops, and terrain masking (5 minute fallout), using airborne collections. ($12.0M)

- Starlite program - Develop detailed engineering designs, producibility data, and performance analysis substantiating technical feasibility and cost estimate of 1.5-D space-qualified electronically scanned antenna. Demonstrate 3x resolution gain with sparse band at low SNR. Demonstrate 10x reduction in revisit rate required via angular diversity on target. ($15.0M)

- Integrate advanced 3-D radar technologies developed under the 3-D High-Resolution Digital Terrain Mapping program (PE: 0602702E, Project: TT-03) to the Starlite concept. ($3.0M)

- The Novel Antennas Program - A non-real-time demonstration will be followed by a real-time demonstration of emitter selection and precision location in a dense interference environment. ($13.0M)

(U) **Program Change Summary:** (In Millions)

	FY 1997	FY 1998	FY 1999
President's Budget	0	33.5	58.0
Appropriated	1.5	24.5	N/A
Current Budget	1.5	19.6	70.5

(U) **Change Summary Explanation:**

FY 1998 Decrease reflects reprogramming of the Novel Antennas program to another program element and the deferral of the Eclipse program.

FY 1999 Increase reflects a rephasing of the Novel Antennas program, repricing of the Passive Millimeter Wave Imaging and RF Tags programs, and initiation of the Starlite program.

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(U) **Other Program Funding Summary Cost:** *(In Millions)*

Passive Radar Tags

	FY 1997	FY 1998	FY 1999
Source			
DARO	1.0	1.0	-

Adaptive Spectral Reconnaissance

	FY 1997	FY 1998	FY 1999
Source			
DARO	4.0	4.0	4.0

Starlite

	FY 1997	FY 1998	FY 1999
Source			
NRO	-	14.0	13.5
Air Force	-	4.0	13.5

(U) **Schedule Profile:**

Plan   Milestones

Millimeter Wave Imaging System:

Feb 98   Define Detection System Concept of Operation.
Mar 98   Initiate W band targeting system, trade studies, signature characterization, and identification of
         critical technology elements.
May 98   Define Classification System Concept of Operation.
Aug 98   Preliminary Design Review (Detection System).
Aug 98   Complete trade studies and initiate concept development finalize critical technology elements.
Dec 98   Complete concept development, W band targeting lab demonstrations, initiate concept of operations
         development.
Jan 99   Critical Design Review (Detection System).
Jan 99   Issue integrated system RFP.
Feb 99   PDR W band targeting system.
Mar 99   Preliminary Design Review (Classification System).
Apr 99   Begin integrated system development.
May 99   Sub-Scale Ground Test (Detection System).
Jun 99   Complete signature characterization, field testing of W band targeting system.

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Aug 99   Critical Design Review (Classification System).
Oct 99   Full scale Ground Test (Detection System).
Oct 99   Complete proof-of-concept testing of 94 GHz system.
Oct 99   CDR W band targeting system.
Sep 00   Flight demo W band targeting system, CDR integrated targeting/imaging system.
Sep 01   Flight demo W band integrated targeting/imaging system.
Radar Tags:
Jan 98   Concept Analysis.
May 98   System Design.
Sep 98   Fabricate brass board RF Tags.
Sep 98   Modify airborne Synthetic Aperture Radar (SAR) processors and ground stations.
Nov 98   Test brass board Radio Frequency (RF) Tags.
Nov 98   Test airborne SAR processors and ground stations.
Jan 99   Performance flight test RF Tags to verify system operation.
Sep 99   Fabricate miniaturized RF Tags.
Sep 99   Develop system test plan.
Adaptive Spectral Reconnaissance:
May 98   Demonstrate prototype system.
May 98   Release RFP for system development.
Aug 98   Award system development contract.
Nov 99   Delivery of spectral system.
Tactical Radar:
Nov 98   Start development of less than mature critical technology areas.
Jun 99   Complete concept designs.
Novel Antennas:
Aug 99   Real-Time Proof-of-Concept Demonstration.

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COST *(In Millions)*	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Air Defense Initiative SGT-03	18,854	20,906	33,050	53,130	27,180	30,560	35,000	Continuing	Continuing

(U) **Mission Description:** This Project encompasses several advanced technologies related to the development of techniques to counter advanced battlefield threats. These programs include the Synthetic Aperture Radar Electronic Counter-Countermeasures (SAR ECCM) Program, the Mountain Top Program, the Air-Defense Simulation Program, the Advanced Signal Processing (ASP) Program, the Low-Cost Cruise Missile Defense (LCCMD) Program, and the Air Directed Surface-to-Air Missile (ADSAM) Program.

(U) The SAR ECCM Program will develop techniques to make U.S. Synthetic Aperture Radar (SAR) systems less vulnerable to intentional enemy jamming or deception. SAR systems have become one of the most widely used broad area surveillance systems. They are critically important to the development of battlespace awareness and their jamming and/or deception could seriously degrade U.S. warfighting capability. The SAR ECCM program will determine the military impact of various SAR jamming techniques and develop countermeasures against the highest priority threats.

(U) The Air-Defense Simulation (Transition Support) Program conducts integrated analysis, modeling, simulated exercise, and demonstration efforts to develop Advanced Air Combat Concepts (A2C2) using DARPA technologies to facilitate technology transition to the Services. Examples include advanced fire control support for Air Force and Navy fighters as well as air directed surface-to-air missile (ADSAM) operations of Army and Navy systems. Analysis and modeling efforts will be performed to develop and refine employment architectures and concepts of operations (CONOPS) utilizing DARPA technologies. Primary vehicles for these efforts will be in-house analysis, contracted studies, support for the Joint Staff (J-8) led Joint Cruise Missile Defense (JCMD) Study, and seminar wargames used to create and assess robust warfighting concepts supported by DARPA technologies. Selected portions of warfighting concepts will be demonstrated using these tools to validate key capabilities of DARPA technologies. Field demonstration scenarios will be derived from the analysis and modeling effort, combined with simulated exercises to facilitate operator involvement early in the process. CMD study plans call for DARPA to be a node on the Distributed Interactive Simulation (DIS) network with multiple Service Modeling and Simulation activities. Simulated exercises will concentrate on distributed interactive simulation (DIS) in addressing CONOPS and Ballistic Missile (BM) C4I issues, while field demonstrations will highlight sensor operational effectiveness and treat transition-related factors in more depth.

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(U) The Low Cost Cruise Missile Defense (LCCMD): This program employs emerging missile seeker technologies to provide cost effective approaches to defeat proliferated asymmetric airborne threats. These threats include cruise missiles, unmanned air vehicles capable of conducting surveillance or jamming surveillance, fire control, communications and navigation systems, as well as slow, low-flying manned aircraft such as helicopters and fixed-wing aircraft capable of dispensing chemical or biological agents. Various seeker options will be investigated, focusing on the development of very low cost, highly capable seekers which can be integrated into a missile interceptor and be deployed in large numbers.

(U) ADSAM: The purpose of this joint DARPA/AMCOM/AMCOM/USMC/AMRAAM program office project is to rapidly demonstrate enabling technologies and operational concepts to support the destruction of low flying, difficult to detect targets, such as cruise missiles. This project demonstrates the critical technologies required to destroy such difficult to detect targets beyond the line-of-sight and at the full intercept range of surface-to-air missile systems. This live fire demonstration program uses an elevated platform to provide target cueing and updates to Advanced Medium Range Air to Air Missiles (AMRAAM). These missiles are ground launched from modified High Mobility Multi-Purpose Wheeled Vehicles (HMMWV) developed by DARPA and AMCOM, known as the HUMRAAM. This demonstration program also supports the Marine's ongoing HUMRAAM program, called the Complimentary Low Altitude Weapons System (CLAWS), by allowing them to quickly progress from concept development through demonstration/validation in less than 1 year. Early successes with the HUMRAAM have led the Marines to include its further development and acquisition in their FY 2000 POM, and the Army to seek FY 1999 funding under their Warfighter's Rapid Acquisition Program (WRAP).

(U) **Program Accomplishments and Plans:**

(U) **FY 1997 Accomplishments:**

- Mountain Top Program: The Memorandum of Agreement between DARPA and the Navy was finalized and the RSTER asset was transferred to the E-2C Program Office, PMA-231. ($4.8M)
- Simulation: An operator in the loop simulation (OITL) capability was established to simulate various advanced combat concepts for cruise missile defense (CMD) by off board sensor support. Planning for the F16 demonstrations was continued and some software modifications were accomplished to support live fire demonstrations. Support for the J-8 LACMD study was continued. A joint system integration test was accomplished in May 97. ($7.2M)
- Advanced Signal Processing: This program employed the virtual STAP Algorithm Development Support Environment at MHPCC to design and develop advanced STAP algorithms for future AEW radar. The program was completed in FY 1997 with the delivery of fieldable radar processing STAP algorithms. ($5.4M)

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(U)
- SAR ECCM: A study panel conducted the first phase of a parametric study assessing the electronic counter measures (ECM) vulnerability of modern airborne intelligence, surveillance and reconnaissance (ISR) SAR systems. The study panel also identified and evaluated candidate electronic counter countermeasures (ECCM) techniques that would be applicable for these systems. ($1.5M)

FY 1998 Program:
- Low Cost Cruise Missile Defense (LCCMD): The concept development efforts initiated in FY 1997 will be completed and a design effort will commence with the most promising concepts. Additionally, a BAA will be issued that solicits advanced seeker concepts to defeat an expanded array of asymmetric airborne threats. FY 1997 funding was budgeted under a different PE. ($10.4M)
- SAR ECCM: The study panel will complete their analyses of ISR SAR ECCM vulnerability and candidate ECCM technique performance. Data to support analysis and algorithm design will be collected with a representative ISR SAR system located on DARPA's Sensor Emulation Platform, (SEP). ECCM techniques applicable to the SEP class of ISR radars will be analyzed and performance versus implementation costs will be analyzed. ($5.7M)
- ADSAM: Final system components will be procured, integrated and tested. A series of tests will be conducted, leading to the simultaneous live fire demonstration in which two HUMRAAM missiles will destroy two simultaneously launched low-flying cruise missile targets. Upon successful completion of this May 98 demonstration, the residual assets (2 HUMRAAM's with associated hardware and software) will be dispositioned to the Marine Corps to support their ongoing Complimentary Low Altitude Weapons System (CLAWS) program. ($4.8M)

FY 1999 Program:
(U)
- LCCMD: The concept development, design and subsystem development efforts begun in FY 1998 will be completed. Further design and fabrication of test articles for captive flight testing will begin. ($25.0M)
- SAR ECCM: The hardware implementation of SAR ECCM algorithms will commence. Design efforts and test planning will get underway in preparation for a proof of principle demonstration scheduled for FY 2000. ($8.1M)

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(U) **Program Change Summary:** *(In Millions)*

	FY 1997	FY 1998	FY 1999
President's Budget	21.8	18.1	29.0
Appropriated	21.4	17.6	N/A
Current Budget	18.9	20.9	33.1

(U) **Change Summary Explanation:**

FY 1997 Decrease reflects minor repricing and reprograming to SBIR program.
FY 1998 Increase reflects requirement for additional LCCMD funding.
FY 1999 Increase reflects realignment of program priorities.

(U) **Other Program Funding Summary Cost:** N/A

(U) **Schedule Profile:**

Plan   **Milestones**

LCCMD:
Jan 98   Concept Downselect.
Jun 98   Advanced Seeker BAA selection.
Sep 98   Concept SDR.
Mar 99   Concept PDR.
SAR(E) CCM:
Jun 98   SEP data collection.
Jan 99   Algorithm/Hardware Implementation.
ADSAM:
Phase I (HUMRAAM):
Mar 98   Test Readiness Review.
May 98   Live Fire Demo.
Jun 98   Transition to USMC.

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COST (In Thousands)	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Sensor and Exploitation Systems SGT-04	71,000	90,007	72,732	53,250	52,307	80,412	92,832	Continuing	Continuing

(U) **Mission Description**: This project funds key sensor demonstrations and the exploitation of sensor products. These efforts, in conjunction with those described in Project CCC-02 (Information Integration Systems) seek to develop the systems needed to provide the warrior with situational awareness and battlefield dominance. The strategic goals of this project are to: develop key sensor technologies required to support dominant battlefield awareness including sensors which can counter Camouflage, Concealment and Deception (CC&D); provide near-real-time, semi-automatic, exploitation of wide-area moderate (and high) resolution imagery; and provide semi-automated recognition and birth-to-death tracking of high value units and critical moving targets. These goals are being addressed by the Counter CC&D Program, the Semi-Automated Imagery Intelligence (IMINT) Processing (SAIP) Advanced Concept Technology Demonstration (ACTD), Moving and Stationary Target Acquisition and Recognition (MSTAR), Moving Target Exploitation (MTE), and Automatic Target Recognition (ATR) applications programs.

(U) The goal of the Counter CC&D Program is to provide significant enhancement of the military's capability to detect obscured targets hidden under natural and artificial camouflage. Specific goals include validation of Foliage Penetration (FOPEN) target detection capability (0.1 FA/sq.km max) with data from the P-3 Ultra-Wideband UHF Synthetic Aperture Radar (SAR) testbed and the DARPA-sponsored Swedish Carabas II Very High Frequency (VHF) SAR tests; and demonstrations of real-time processing of FOPEN high resolution SAR image formation, Radio-Frequency Interference (RFI) suppression and Automatic Target Detection/Classification (ATD/C) algorithms. A FOPEN Airborne Demonstration Radar will be developed for demonstration on a manned platform providing inputs via narrowband tactical data links for ground image exploitation. The image exploitation processing of SAIP will be extended for FOPEN as well as Multi/Hyper Spectral Image (M/HSI) sensor input, geolocation and sensor fusion processing of images, and detection of time critical targets. The program will ultimately combine FOPEN Radar on the Global Hawk High Altitude Endurance Unmanned Aerial Vehicle (HAE UAV) with other airborne sensors (e.g., the Senior Year Electro-optical Reconnaissance System on the U-2, and develop combined exploitation technologies for insertion into the DARO Common Imagery Ground/Surface System (CIGSS).

(U) The Semi-Automated IMINT Processing (SAIP) ACTD will develop, test and transition to the operational user, automated algorithms and semi-automated tools that enhance the warfighter's capability to: process SAR, and later EO imagery; conduct wide-area search for Ground Order of Battle and Missile Order of Battle targets; perform rapid site

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modeling and site monitoring; and produce target reports in near real-time (< five minutes). Goals for the baseline system are: automatic target cueing and classification for a limited set of vehicles (10 targets); object level change detection; force recognition to the company level; and interactive target recognition and terrain delimitation. Goals for an enhanced system are: Increasing the automatic target cueing and classification to 20 targets; site modeling and monitoring with EO and SAR; and addition of SIGINT cueing. Goals for an enhanced fielded system are to increase automatic target recognition to 30 targets.

(U) The goal of the Moving and Stationary Target Acquisition and Recognition (MSTAR) program is to achieve a major advance in Automatic Target Recognition (ATR) performance on SAR imagery through fundamental and innovative technology developments and to transition this technology to fielded systems with ATR requirements. The approach to detect stationary targets utilizes traditional ATR techniques to first determine suitable target candidates for image regions of interest (ROIs). A predictive model-driven subsystem then refines these candidates to determine the target ID of the ROI. Other program goals include: significant advances in interactive image exploitation environments and performance; development of rapid target model construction; development of resource management systems for surveillance and exploitation, and development and demonstration of ATR- and compression-based techniques to reduce communication bandwidths for SAR-based wide area search platforms to SATCOM-supportable bandwidths. Two approaches are being investigated and evaluated: A single scale approach that combines existing SAR image formation processing with ROI detection and compression algorithms; and a multi-scale approach that embeds detection within the image formation processing to greatly reduce implementation complexity. Specific applications are targeted for the U-2 AIP and Global Hawk platforms although other reconnaissance and surveillance platforms that disseminate SAR imagery could also benefit from Intelligent Bandwidth Compression (IBC) technology.

(U) The Moving Target Exploitation (MTE) program's objective is to achieve a major advance in computer-assisted interpretation of Moving Target Indicator (MTI) radar data by providing previously unavailable capabilities to automatically detect, track, and classify high-valued ground-moving targets and maneuvering formations using all-weather airborne surveillance radar data. Four techniques are being investigated and evaluated: the automatic tracking of ground moving vehicles; the automatic analysis of moving vehicle motion patterns and behavior patterns to identify purposeful military movement; the discrimination of desired targets from other moving vehicles using high range resolution (HRR) MTI range profiling and 1-D automatic target recognition; and the imaging of specific moving targets via enhanced moving target imaging (MTIm) processing. Specific applications are targeted for MTI sensors on board the Joint Surveillance, Target, and Attack Radar System (Joint STARS), U-2, and Global Hawk platforms.

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System-level approaches for the application of complex-data techniques will be developed and integrated, including scatterer-specific imaging (SSI) for enhanced ATR with reduced false-alarm rates and systematic applications of coherent change-detection (CoCD).

(U)   The goal of the Congressionally-mandated Geographic Synthetic Aperture Radar (GeoSAR) Program is to develop and test an airborne, radar-based foliage penetration/terrain feature mapping and geographic information system with an emphasis on both defense and civil applications.

(U)   The goal of the Low-Cost Hypersonic Interceptor (LCHI) program is to cooperatively employ US and Russian expertise and low-cost approaches to develop and demonstrate a low-cost, ground-launched, hypersonic interceptor airframe.

(U)   **Program Accomplishments and Plans:**

(U)   FY 1997 Accomplishments:

- Completed Foliage Penetration (FOPEN) Concept Development and verified the System Requirements for a FOPEN Airborne Demonstrator radar targeted for a Medium or High Altitude Endurance (MAE/HAE) Unmanned Aerial Vehicle. Completed critical technology demonstration of ultra-wideband antenna design, airborne real-time processing interface, radio-frequency interference suppression, and FOPEN automatic target detection/classification. Developed and prototyped Image Exploitation algorithms for FOPEN and EO (MSI) sensors within the SAIP exploitation architecture. Completed a demonstration of Counter CC&D Sensors in orchestrated exercise at Keystone97 to collect sensor data for verification of FOPEN SAR and Multisensor Exploitation. ($13.7M)

- Transition and integration of component modules into the SAIP ACTD was completed to achieve both baseline and enhanced system objectives in continued collaboration with the Defense Airborne Reconnaissance Office (DARO) and the National Imagery and Mapping Agency (NIMA). The site modeling and monitoring components were integrated and additional Missile Order of Battle and Ground Order of Battle target models and algorithms were inserted. Tests and demonstrations were conducted to demonstrate system performance with operational airborne theater sensor (U-2 ASARS, ETRAC) imagery. ($24.9M)

- The MSTAR target recognition system was matured to deal with 15 targets and incorporate limited extended operating condition (EOC) capability including identification in the presence of target articulation and obscuration. Transition to SAIP ACTD of the MSTAR target signature prediction module has occurred. Concepts for interactive exploitation and rapid target insertion have been developed; prototypes are being

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	DATE February 1998

APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 3 Advanced Technology Development

R-1 ITEM NOMENCLATURE
Sensor and Guidance Technology,
PE 0603762E, Project SGT-04

developed for FY 1998 demonstration and evaluation. A single-scale ATR-based bandwidth compression system was demonstrated in a laboratory environment and was demonstrated in a laboratory configuration of mobile stretch. The performance of the single-scale compression approach with the SAIP SAR exploitation system was analyzed. A multi-scale IBC architecture was developed and demonstrated in a laboratory environment. Both single- and multiple-scale approaches were evaluated for real-time hardware and software integration onto the U2-AIP and Global Hawk platforms. ($13.7M)

- The Moving Target Exploitation (MTE) program completed the integration and evaluation of MTE target classification technology components in a ground-based component testbed; real-time moving target classification (HRR, MTIm, 1-D and 2-D ATR techniques) was demonstrated using HRR recorded data and simulated MTIm data. Vehicle motion pattern analysis and behavior pattern analysis (MPA/BPA) techniques were investigated and an automated algorithm was developed to detect purposeful military movement in MTI data. A simulation test bed was developed to investigate, evaluate, and demonstrate enhanced ground tracking capabilities and preliminary techniques for MPA/BPA using scalable scenarios. The MTE program, in coordination with USAF ESC/JS, recorded MTE data using the Joint Surveillance, Target, and Attack Radar System (Joint STARS) in FY 1997, and this data will be processed in the ground-based testbed. System analysis and trade studies were conducted to identify an architecture to transition MTE technologies to the U-2 AIP and Global Hawk platforms. ($6.0M)

- Complete ground test demonstration of the GeoSAR P-Band radar, and critical design review of P-Band and X-Band radar. ($12.7M)

(U) FY 1998 Program:

- The Counter CC&D Program will develop a Foliage Penetration (FOPEN) Airborne Demonstrator radar for test and evaluation on a manned platform, providing inputs via narrowband tactical data links to the image exploitation capabilities in the SAIP ground processing facility. The Image Exploitation techniques developed under SAIP will be extended to include unique characteristics of VHF/UHF band FOPEN radar, high spatial resolution U2 SYERS MSI sensor, and high spectral resolution Predator HSI sensor, and multisensor correlation to improve the reliability of detection and discrimination of tactical targets under camouflage and foliage cover. ($22.7M)

- Continue GeoSAR P-Band and X-Band radar efforts. ($10.3M)

- Semi-Automated IMINT Processing (SAIP) integration and field testing will continue towards transition system objectives and to support the global Hawk UAV SAR, the U-2 ASARS-2, and the ASARS Improvement Program. Transition to the operational customer, U.S. Atlantic Command, will begin. ($24.5M)

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- The MSTAR target recognition system will be integrated and evaluated, then matured into a 20 target system with the ability to handle articulated, obscured, realistic target imagery under a variety of operating conditions. The system will be fully characterized using a large database of target and clutter imagery. Transition of the MSTAR system to SAIP and Counter CC&D ACTDs will occur. Full prototypes for interactive exploitation for two analyst missions will be developed and evaluated. A rapid target insertion prototype system will be built and evaluated, creating 5 target models and rapid ATR training systems as a baseline. A resource management prototype will be built and evaluated. The best performance components of the single-scale and multiple-scale approaches will be combined to develop an integrated, real-time demonstration for the U2-AIP or Global Hawk and in support of a potential SAIP exploitation system split-based operation. Airborne and field demonstrations are planned utilizing the Sensor Emulation Platform (SEP). ($16.6M)

- The MTE program will demonstrate, near-real-time operational MTE performance against high-value moving targets by integrating the classification component and simulation testbeds developed in FY 1997 into a single MTE system testbed. This testbed will be exercised with recorded Joint STARS data. In parallel, more extensive MPA/BPA tools will be investigated, developed, and exercised and evaluated in a ground station simulation testbed. The ground station simulation testbed will emulate the MTE data that will be available from the U2-AIP and Global Hawk platforms. The moving target classification (HRR, MTIm, 1-D and 2-D ATR) techniques will be evaluated and demonstrated for U2-AIP and Global Hawk sensor parameters and using recorded data from the SEP. A coordinated Joint STARS and SEP data collection will be conducted to provide MTE data from multiple platforms of instrumented moving ground vehicles. Two mature techniques, scatterer-specific imaging (SSI) and coherent change detection (CoCD) will be adapted to operate with the X-band class of radar sensors. Performance will be evaluated using bounds analysis techniques to determine robustness of the coherence-based techniques with X-band sensors. ($15.7M)

- A joint U.S. and Russian team will evaluate Low-Cost Hypersonic Interceptor (LCHI) alternatives. ($.2M)

(U) FY 1999 Program:

- The Counter CC&D Program will complete integration of a FOPEN SAR Manned Airborne Demonstrator with a tactical data link and a Ground Control and Display System to verify Global Hawk HAE UAV performance requirements. A laboratory demonstration of the Multisensor Exploitation Testbed will be conducted in preparation for FY 2000 development tests of FOPEN and SYERS MSI Exploitation and Counter CC&D Tests. ($25.0M)

- The SAIP USACOM Operational Assessment, with final transition configuration of system stood up, will be performed and demonstration of all software upgrades and transition will be conducted. ($9.5M)

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- The evaluation of the MSTAR 20 target/full extended operating condition (EOC) system will be completed, system technology will be transferred to the SAIP and STARLOS programs, and a three year effort to develop a high performance computing adaptation for an MSTAR real time demonstration system will begin. Also, an effort to develop a MSTAR model-driven ATR will be extended to accommodate moving targets using MTE technology. Multiple modes of radar processing (High Range Resolution, Inverse SAR, phase history) shall be utilized to improve performance on moving and stationary targets. Development and evaluation of rapid target insertion interactive exploitation systems will continue, with key milestones occurring in FY 2000. ($22.5M)

- The MTE program will demonstrate MTE on-board the Joint STARS platform and will demonstrate MTE processing in a ground-station environment with live data from Joint STARS and SEP. ($15.7M)

(U) **Program Change Summary:** *(In Millions)*

	FY 1997	FY 1998	FY 1999
President's Budget	69.2	82.6	77.0
Appropriated	75.7	89.7	N/A
Current Budget	71.0	90.0	72.7

(U) **Change Summary Explanation:**

FY 1997 Reduction reflects program adjustments and reprogramming to SBIR program.
FY 1998 Reduction reflects repricing and rescoping of the Low Cost Hypersonic Interception program to a study effort.
FY 1999 Reduction reflects deferral of the full Low Cost Hypersonic Interceptor program.

(U) **Other Program Funding Summary Cost:**   N/A

(U) **Schedule Profile:**

Plan   Milestones
Jan 98   Laboratory Demo of FOPEN and HSI/MSI Image Exploitation on SAIP Architecture processors.
Jan 98   Ground moving target Joint STARS data collection to support. MET MPA/BPA and tracker development.

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Mar 98 Field demonstration of ATR-based compression using MOBSTR in split-based configuration.

May 98 Laboratory Demo of FOPEN and MSI Image Exploitation on CIGSS Architecture processors.

Apr 98 Real-time operational airborne demonstration of MTE tracker and control infrastructure system with Joint STARS.

Jun 98 LCHI procurement and joint US/Russian team finalized.

Jul 98 Airborne data collection using SEP to support development of MTE components compatible with U-2 and Global Hawk radars.

Jul 98 GeoSAR Radar, Ground Processing Development Test and Performance Baseline.

Aug 98 Airborne demonstration of ATR-based compression using SEP.

Aug 98 Demonstrate advanced MTE MPA/BPA algorithms and target classification components in ground-station simulation testbed environment.

Oct 98 GeoSAR Aircraft Modifications complete for radar installation.

Nov 98 Final MSTAR ATR demo: 20 targets, full range of EOCs; transition system to SAIP.

Nov 98 Start Integration of FOPEN Airborne Demonstration Radar.

Apr 99 Airborne MTE demonstration with Joint STARS.

Jul 99 Complete integration of SAIP transition configuration.

Jul 99 GeoSAR foliage penetration interferometric mapping validated.

Aug 99 Demonstrate MPA/BPA and multi sensor classification techniques in a MTE ground-station testbed with real-time data from Joint STARS and SEP.

Sep 99 Multi-Sensor Exploitation Testbed Demonstration.

Sep 99 Flight demonstration of FOPEN Radar on Manned Platform.

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APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 3 Advanced Technology Development

R-1 ITEM NOMENCLATURE
Marine Technology,
PE 0603763E, R-1 #53

COST (In Thousands)	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Marine Technology	**41,185**	**19,626**	**24,788**	**33,998**	**43,464**	**59,196**	**68,696**	**Continuing**	**Continuing**
Arsenal Ship MRN-01	19,366	0	0	0	0	0	0	0	N/A
Advanced Ship-Sensor Systems MRN-02	21,819	19,626	24,788	33,998	43,464	59,196	68,696	Continuing	Continuing

(U) **Mission Description:** The Marine Technology Program is budgeted in the Advanced Technology Development budget activity because its objective is to identify and mature critical enabling technologies for maritime systems, and to develop and demonstrate advanced system concepts to counter the threat created by the worldwide spread of increasingly sophisticated naval technology. The growing threat of quiet diesel/electric (DE) submarines, the continuing worldwide proliferation of advanced submarine and weapons capabilities, and the easy availability of modern underwater mines all necessitate the development of increasingly affordable far-term solutions for enhancing the operating capabilities and the survivability of U.S. naval forces in the littoral. The Advanced Ship-Sensor Systems project (MRN-02) provides the innovative technologies that allow our naval forces to maintain and improve their effectiveness in operating forward from the sea in the ever more dangerous conditions of future tactical environments.

(U) The Hydrodynamics Program has developed and demonstrated technological advances in flow phenomena and their application to maritime platforms, including surface ships, submarines, and torpedoes, and is determining the feasibility of extending these technologies to other flow control systems such as air and heat transfer. The two major projects in this area are Electromagnetic Turbulence Control (EMTC), which is demonstrating the capability of using an electromagnetic field to control the turbulent boundary layer (and thereby reduce drag noise), and Supercavitation, which is investigating the potential of high speed underwater projectiles.

(U) The Active Cancellation Program is developing and applying active structural control technology to attenuate airframe vibration and internal noise that will result in reduced helicopter maintenance cost, increase operational availability and service life, and improve habitability for aircrew and passengers. New modular components will be developed that can be installed as retrofits or included in new designs.

(U) The Shallow Water Sonar Technology Program has developed and demonstrated advanced passive and active processing technologies that significantly enhance the sonar performance of fleet units in adverse shallow water acoustic environments. The Multi-Static Active (MSA) Sonar project has demonstrated a multiple receiver, relocatable

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source system that provides submarine detection ranges to 50 kilometers in littoral regions where etection ranges of less than 10 kilometers are typical.

(U) The Undersea Littoral Water (ULW) program will develop an active acoustic system to greatly enhance the detection, classification, and targeting performance against low-observable submarines and mines in littoral areas by applying novel acoustic activation, signal processing, and targeting techniques for air, surface, or subsurface targeting. It will also enable high coverage rates for acoustic mine detection and classification and will utilize long range active coherence properties of arrays. The classification/receiver activities in the ULW program have applicability to mine countermeasures as well. This program of acoustic activation combined with structure based classification of submarine and mine targets, and unified by a seamless weapons targeting system (that remains a necessary component of the total cooperative engagement), will greatly enhance acquisition and targeting performance against the quiet threat in the littoral environment.

(U) The Water Hammer program will design, fabricate, and demonstrate a mine neutralization system consisting of a phased array of shock tubes to generate, focus, and transport to militarily important distances (tens of meters) a pressure pulse of sufficient energy to neutralize the threat ($\geq$1000 psi-msec; $\geq$2000 psi). Water Hammer has the potential for rapid, precision, in-stride lane clearance in deep or shallow water, reducing the need for high fidelity detection and classification. While the initial program focuses on mine/obstacle clearance, Water Hammer also has utility as a close-in defense system for ships against underwater threats. Current close-in defense systems are primarily surface based and address surface threats. Water Hammer can potentially provide rapid targeting and destruction of subsurface threats.

(U) The Buoyant Cable Array Antenna (BCAA) program is investigating a full duplex link (transmit and receive) for data transfer and communications to/from submarines while operating at speed and depth. Technologies that may be employed to achieve high data transfer rates from a submerged condition include photonic signal and power links, enhanced antenna loading materials, adaptive array calibration, and enhanced communications protocols.

(U) **Program Accomplishments and Plans:**

(U) FY 1997 Accomplishments:
- Conducted experimental program for Electromagnetic Turbulence Control (EMTC) technology to address electrode/magnet design, controller design, system optimization and power scaling issues; conducted tests to determine the effectiveness of supercavitating high speed bodies against fixed targets. ($2.7M)
- Designed and fabricated a prototype active transmission vibration isolation mount. ($2.9M)

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RDT&E, Defensewide BA 3 Advanced Technology Development	Marine Technology, PE 0603763E, Project MRN-02

- Completed final at-sea Anti-Submarine Warfare (ASW) demonstration of environmentally adaptive shallow water active sonar technology in conjunction with single/few platform scene generation capability; completed development of autonomous Anti-Submarine Warfare (ASW) multi-target detection technology. ($1.8M)

- Initiated development of the Netted Search, Acquisition and Targeting (NetSAT) for littoral surveillance to include an acoustic source, as well as signal processing for enhanced detection and attack performance. ($4.0M)

- Assessed design of a prototype acoustic mine detection and classification system for a large (10 sq nm/hr) area coverage rate. ($1.4M)

- Developed space-time adaptive processing techniques and performed ocean tests to enhance long range active coherence and towed array detection performance. ($2.2M)

- Conducted first demonstration of a standoff pulsed power mine neutralization system; demonstrated ability to generate a repeatable single tube electro-chemical-thermal reaction. ($0.9M)

- The following Shallow Water Anti-Submarine Warfare (ASW) efforts were funded by Congressional additions to the FY 1997 President's Budget:

  - Extended autonomous ASW detection and classification effort to multiple targets and broader application to fleet systems. Deployed and evaluated autonomous submarine detection and classification processor in operational environment. ($2.8M)

  - Developed advanced signal detection and processing algorithms to mitigate effects of torpedo acoustic countermeasures. ($1.2M)

  - Initiated design and development of a high-resolution synthetic aperture sonar towed-array system for mine detection and classification from high speed platforms. ($1.9M)

(U) FY 1998 Program:

- Continue development, plan, and test proof-of-concept ASW Netted Search, Acquisition and Targeting (NetSAT) system at sea, incorporating a wide frequency band, autonomous, long duration, leave behind acoustic source; signal processing for enhanced detection and attack performance (Distant Thunder); and acoustic space-time adaptive processing. ($11.4M)

- Conduct development of a multi-frequency Interferometric Synthetic Aperture Sonar (IFSAS) for mine classification. ($1.3M)

- Conduct development of smart ASW sensors to support Netted Search, Acquisition and Targeting (NetSAT); investigate feasibility of Robust Passive Sonar (RPS) using space-time processing (STP) techniques; conduct sonar STP and shipping noise characterization experiment. (Congressionally-directed program) ($3.8M)

- Commence development of non-explosive underwater energy projection technology for mine neutralization, including fabrication and test of initial source array test article. ($1.9M)

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RDT&E, Defensewide BA 3 Advanced Technology Development	Marine Technology, PE 0603763E, Project MRN-02

(U)
- Conduct initial technology assessments and feasibility testing of advanced submarine system concepts, including: signal exploitation, antenna array communications, and adaptive waveform generation. ($1.2M)

(U) FY 1999 Program:
- Upgrade system and demonstrate detection-to-attack performance of a prototype ASW NetSAT system, incorporating: full wide frequency band, autonomous, long duration, leave behind acoustic source, autonomous diesel electric detection; signal processing for enhanced attack performance; and acoustic space-time adaptive processing. ($12.5M)
- Assess feasibility of advanced controlled impulsive active sonar for shipboard use. ($1.4M)
- Initiate development of Robust Passive Sonar (RPS) processing; begin expansion of sonar space-time processing (STP) and shipping noise characterization test array. ($4.8M)
- Continue non-explosive underwater energy projection technology development for mine neutralization, including fabrication and test of second source array test article and prototype system design. ($3.9M)
- Initiate design and development of a full duplex (transmit/receive) submarine Buoyant Cable Array Antenna prototype (BCAA). ($2.2M)

(U) **Program Change Summary:**   (In Millions)

	FY 1997	FY 1998	FY 1999
President's Budget	18.8	21.9	38.8
Appropriated	24.4	21.1	N/A
Current Budget	21.8	19.6	24.8

(U) **Change Summary Explanation:**

FY 1997 Decrease reflects repricing of the Acoustic Mine Detection system and the Vibration Isolation Mount effort, and reprogramming for the Small Business Innovative Research program.

FY 1998 Decrease reflects minor repricing and completion of the Electromagnetic Turbulence Control effort.

FY 1999 Decrease reflects realignment of program priorities, eliminating efforts focused on submarine hydrodynamics and structural designs, and Electromagnetic Turbulence Control.

(U) **Other Program Funding Summary Cost:** N/A

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Marine Technology,
PE 0603763E, Project MRN-02

(U) <u>**Schedule Profile:**</u>

<u>Plan</u>	<u>Milestones</u>
1QFY98	Conduct laboratory test of power generation and conversion for an autonomous acoustic source.
1QFY98	Complete airframe shake test of active transmission vibration isolation mount.
2QFY98	Complete fabrication of 2 x 2 Water Hammer source array as initial test article.
3QFY98	Conduct initial feasibility sea test for submarine Buoyant Cable Array Antenna (BCAA) concept.
4QFY98	Conduct Anti-Submarine Warfare (ASW) Netted Search, Acquisition and Targeting (NetSAT) system proof of concept test.
4QFY98	Conduct initial sonar space-time processing and shipping noise characterization experiment.
4QFY98	Complete fabrication of 4 x 4 Water Hammer source array as second test article.
2QFY99	Complete demonstration of 4 x 4 Water Hammer source array.
3QFY99	Conduct Water Hammer array prototype Preliminary Design Review.
4QFY99	Conduct Water Hammer array prototype Critical Design Review.
4QFY99	Conduct at-sea test of prototype NetSAT.

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APPROPRIATION/BUDGET ACTIVITY
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BA 3 Advanced Technology Development

R-1 ITEM NOMENCLATURE
Land Warfare Technology,
PE 0603764E, R-1 #54

COST (In Thousands)	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Land Warfare Technology	**62,381**	**80,924**	**108,490**	**93,413**	**89,700**	**101,500**	**87,000**	**Continuing**	**Continuing**
Rapid Strike Force Technology LNW-01	19,211	42,315	52,600	33,000	28,000	26,000	22,000	Continuing	Continuing
Small Unit Operations LNW-02	43,170	38,609	55,890	60,413	61,700	75,500	65,000	Continuing	Continuing

(U) **Mission Description:** This program element is budgeted in the Advanced Technology Development Budget Activity because it is developing and demonstrating the concepts and technologies that will address the mission requirements of the 21st Century land warrior. Two broad efforts are being pursued in support of this objective: Rapid Strike Force Technology and Small Unit Operations.

(U) The Rapid Strike Force Technology project is developing the technologies necessary for highly mobile, covert transportation and information gathering systems to enhance U.S. early-entry capabilities. The primary thrusts of this project are the Combat Hybrid Power Systems program that is developing and demonstrating hybrid electric power and energy management systems for cavalry/scout vehicles; the Reconnaissance, Surveillance, and Targeting (RST) Vehicle program that is designing, developing and testing components and subsystems for a future lightweight, highly maneuverable manned or unmanned vehicle; the ground vehicle self-protection program which will enhance the survivability of mobile ground vehicles; and the Tactical Mobile Robotics (TMR) program which will develop mobile robotic technologies that will enable land forces to dominate battlespace using individual, or teams, of mobile robots in complex terrain (urban, indoor, rugged).

(U) The Small Unit Operations project is developing the critical technologies that will enable dispersed units to effectively perform warfighting operations that traditionally have required massed forces. Technology development efforts will focus on a comprehensive awareness capability that provides real-time, essential information for small units and individual warfighters; wireless communication technologies to permit exchange of voice, digital and video data with other systems; geolocation technologies that provide navigation information in build-up, forested and mountainous environments; internetted tactical surveillance and targeting sensors to complement information requirements not satisfied by national, theater, and component sensor programs; and automated tasking and control technologies for air and ground systems.

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Land Warfare Technology,
PE 0603764E

COST (In Millions)	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Rapid Strike Force Technology LNW-01	19,211	42,315	52,600	33,000	28,000	26,000	22,000	Continuing	Continuing

(U) **Mission Description:** The emerging U.S. vision of future land warfare places strong emphasis on technology supporting early entry. This project is developing technologies that enable highly-mobile, covert transportation and information gathering systems, which are important aspects of an early-entry capability. The project consists of seven primary efforts: Combat Hybrid Power Systems (CHPS); Molten Carbonate Fuel Cells (MCFC); Helicopter Active Noise and Vibration Control (HANVC); Reconnaissance, Surveillance, and Targeting Vehicle (RST-V); Tactical Mobile Robotics (TMR); Ground Vehicle Self-Protection; and Thermophotovoltaics (TPV). The CHPS, RST-V, and Tactical Mobile Robotics programs are closely coordinated with the U.S. Army, Navy, and Marine Corps, and with DARPA's Electric Vehicle (EV-01) and Small Unit Operations (LNW-02) Programs.

(U) The Combat Hybrid Power System program will develop enabling technologies and conduct demonstrations of an integrated hybrid electric power system that provides power and energy management for all of the electric subsystems throughout the future combat vehicles. The hybrid electric power system will consist of an engine/alternator, sized for average power demand, energy storage and power averaging components which provide both continuous and pulsed power, distribution networks, subsystem controls, and power conditioning devices. Vehicles will be simulated to evaluate subsystem requirements, topologies, and military utility. Hybrid electric power is an enabling technology for future combat vehicles if electrically powered subsystems are to be implemented. The vehicles will have greatly reduced noise and thermal signatures; and improved mobility, survivability, lethality, and fuel economy. By eliminating rigid connections between components, interior layout can be optimized, significantly reducing volumetric constraints. These advantages will result in deployable, affordable combat vehicles that meet mission requirements.

(U) The Carbonate Based Fuel Cells program will develop military enhancements to the Department of Energy's Direct MCFC Program. The enhancements will assist in more rapid introduction of the MCFC power plants for stationary power applications for military bases by adding dual-fuel (natural gas and logistic fuel) and simulator capabilities.

(U) The HANVC program will design, fabricate and demonstrate an Active Rotor Control (ARC) system that should achieve 10dB radiated sound pressure noise reduction, and cancel vibration and noise from the main transmission to reduce maintenance costs and improve passenger comfort.

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BA 3 Advanced Technology Development

R-1 ITEM NOMENCLATURE
Land Warfare Technology
PE 0603764E, Project LNW-01

(U)   The Reconnaissance, Surveillance, and Targeting Vehicle (RST-V) program will design, develop, test/demonstrate, and transition to the Services two hybrid electric drive, lightweight, highly maneuverable advanced technology demonstrator vehicles capable of V-22 internal transport. The vehicle will incorporate technological advancements in the areas of integrated survivability techniques and advanced suspension. The vehicle will also host integrated precision geolocation, communication and RST sensor subsystems provided by DARPA's Small Unit Operations Program. The RST-V platform will provide a mobile quick deployment and deep insertion capable, multi-sensor, battlespace awareness asset for small unit tactical reconnaissance teams, fire support coordinators, and special reconnaissance forces. Critical components and technologies include a high efficiency, reduced signature hybrid electric propulsion system with increased fuel economy; an advanced suspension to increase cross-country speed, and provide platform stabilization; an advanced integrated survivability suite; and the capability to operate in either a silent watch/silent movement or mechanical mode. The vehicle will incorporate modularized design components to allow for signature management and rapid reconfiguration for mission tailoring and multiple purpose utility. The Marine Corps will develop vehicle concepts and chassis, integrate the DARPA developed components, and conduct vehicle performance tests (PE 0603640M) through participation in scheduled Advanced Warfighting Experiments (AWEs) and Advanced Concept Technology Demonstrations (ACTDs) (e.g. Capable Warrior).

(U)   The Tactical Mobile Robotics (TMR) program will develop mobile robotic technologies that will enable land forces to dominate the battlespace using teams of mobile robots in complex terrain (urban, indoor, rugged). TMR provides the potential for intelligent, cooperative platforms integrated with a large variety of payloads for missions that take place in inaccessible or highly dangerous environments, concentrating particularly on urban environments. Specific robotic technologies that will be advanced include perception, autonomous operation, and locomotion. Perception capabilities will include: (a) an on-board multi-sensor perception system capable of detecting at least 80 percent of decimeter-scale terrain hazards and at least 95 percent of meter-scale terrain hazards, both at 20 Hz, and (b) multi-source mapping algorithms capable of creating topological maps of urban structures with 90% accuracy. Autonomous operation capabilities will include: (a) coordination of the tactical behavior of a 10-robot team with 10X fewer command cycles, and (b) traversal of rugged/complex terrain using 1 command per 100 m travel. Locomotion capabilities will feature sub-meter-scale vehicles traveling at up to 1 m/s over 25 cm steps and decimeter-scale rubble.

(U)   The Ground Vehicle Self-Protection Program will develop an Ultraviolet (UV) solar blind solid state focal plane array to significantly enhance the survivability of mobile ground vehicles against the threat of advanced tactical guided missiles at greatly reduced cost.

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(U) The Thermophotovoltaics (TPV) program will develop and demonstrate thermophotovoltaic (TPV) technology and systems. TPV is expected to be an efficient way to convert logistic fuel into electricity at power levels below 5 kW.

(U) **Program Accomplishments and Plans:**

(U) FY 1997 Accomplishments:

- Combat Hybrid Power Systems (CHPS). ($10.0M)
  - Established subsystem requirements, set component specifications, and provided modeling support to hybrid electric power system technology development.
  - Completed detailed design of hybrid electric power system demonstration.
  - Completed design and conducted proof of concept experiments.
- Carbonate Based Fuel Cells. ($2.4M)
  - Developed an operator training simulator, audio-visual simulator, and maintenance procedures for a dual-fuel Molten Carbonate Fuel Cells (MCFC) power plant.
- Helicopter Active Noise and Vibration Control (HANVC) program. ($1.9M)
  - Designed and fabricated prototype components of the active rotor control concept.
- Thermophotovoltaics (TPV). ($4.9M)
  - Developed and demonstrated a TPV power system in the form of a BA-5590 battery but with three times the energy.
  - Demonstrated a portable TPV system in the field.

(U) FY 1998 Program:

- Combat Hybrid Power Systems (CHPS). ($19.2M)
  - Integrate simulation/modeling with laboratory demonstration hardware to provide hardware in the loop demonstration of virtual prototype.
  - Integrate hybrid electric power system subsystems for laboratory demonstration.
  - Develop technology and initiate fabrication of selected full-scale engine/alternator, power averaging, power conditioning, and power distribution and control components.
- Helicopter Active Noise and Vibration Control (HANVC) program. ($5.2M)
  - Fabricate and wind tunnel test a Mach scale actively controlled rotor.
  - Test active transmission mounts on a benchtop rig and on an S-76 helicopter rig.
  - Conduct near full scale fixed wing testing of an actively controlled rotor.

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	DATE February 1998

APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 3 Advanced Technology Development	Land Warfare Technology PE 0603764E, Project LNW-01

- Conduct testing of eddy current vibration sensors.

- Reconnaissance, Surveillance, and Targeting Vehicle (RST-V).   ($5.8M)
  - Design, develop, and test critical components for hybrid electric power system, mobility subsystems, and survivability suite.

- Tactical Mobile Robotics (TMR).   ($12.1M)
  - Develop advanced concepts of operation for Tactical Mobile Robotics in urban missions.
  - Demonstrate tasking and control of multiple robotic vehicles from single workstation.
  - Initiate technology development for robot perception, autonomy, and locomotion.
  - Initiate designs of integrated system.

(U) FY 1999 Program:

- Combat Hybrid Power Systems (CHPS).   ($20.0M)
  - Complete development of critical enabling technology for high risk power system components.
  - Utilize hardware in the loop future combat vehicle virtual prototype to support technology development, and transition technology to USMC and U.S. Army Advanced Technology Demonstrators.
  - Test and evaluate hybrid electric power system in a laboratory demonstration.

- Reconnaissance, Surveillance, and Targeting Vehicle (RST-V).   ($9.0M)
  - Fabricate and demonstrate critical RST-V subsystems including: power system, propulsion, suspension, survivability, and controls.

- Tactical Mobile Robotics (TMR).   ($19.6M)
  - Refine concepts of operation for Tactical Mobile Robotics in urban missions.
  - Demonstrate breadboard robot perception, autonomy, and locomotion capabilities in urban scenarios.
  - Evaluate competing designs for integrated system.

- Ground Vehicle Self-Protection Program: ($4.0M)
  - Initiate development of an Ultraviolet (UV) solar blind solid state focal plane array to significantly enhance the survivability of mobile ground vehicles against the threat of advanced tactical guided missiles at greatly reduced cost.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Land Warfare Technology PE 0603764E, Project LNW-01

DATE February 1998

(U) **Program Change Summary:** *(In Millions)*

	FY 1997	FY 1998	FY 1999
President's Budget	15.0	29.0	38.5
Appropriated	19.0	32.9	N/A
Current Budget	19.2	42.3	52.6

(U) **Change Summary Explanation:**

FY 1997   Increase reflects repricing of the Combat Hybrid Power System program.

FY 1998-99   Increase reflects: Repricing of the Reconnaissance, Surveillance, and Targeting Vehicle (RST-V) Program; Merging and repricing of the Tactical Mobile Robotics (TMR) Program - combination of the Covert Subterranean Probe Program (LNW-01) and the Cooperative Mobile Sensors, Tasking & Control, and Robotics efforts formerly funded under the Small Unit Operations Project (LNW-02); and the introduction of the Ground Vehicle Self-Protection Program.

(U) **Other Program Funding Summary Cost:**   *(In Millions)*

	FY 1997	FY 1998	FY 1999
PE 0603640M Marine Corps Advanced Technology	2.0	2.7	2.8
PE 0603709D Joint Robotics Program	1.7	-	-

(U) **Schedule Profile:**

Plan   Milestones

Feb 98   Preliminary mission requirements defined Tactical Mobile Robotics (TMR).

Apr 98   Begin fixed wing testing of near full scale actively controlled rotor of Helicopter Active Noise and Vibration Control (HANVC).

Apr 98   Complete a field demonstration of a portable Thermophotovoltaics (TPV) system.

Apr 98   Completion of RST-V preliminary designs.

May 98   Begin benchtop demonstration of an active transmission mount for HANVC.

Aug 98   Complete integration of initial hardware into near-term combat hybrid power system integration lab (SIL), including test plan.

Sep 98   Begin wind tunnel tests of the Mach-scale active rotor system for HANVC.

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RDT&E, Defensewide
BA 3 Advanced Technology Development

R-1 ITEM NOMENCLATURE
Land Warfare Technology
PE 0603764E, Project LNW-01

Sep 98	Conduct S-76 demonstration of an active transmission mount for HANVC.
Sep 98	Test RST-V critical components.
Sep 98	Complete perception, autonomous navigation, & locomotion technology breadboards (Tactical Mobile Robotics (TMR)).
Oct 98	Conduct RST-V critical design review and contractor down select.
Oct 98	Complete simulators and procedures for dual-fuel Molten Carbonate Fuel Cells (MCFC) power plant.
Jun 99	Demonstrate hardware in the loop virtual prototype of combat hybrid power system.
Aug 99	Design of robotic perception, autonomous navigation, and locomotion technology brassboards (TMR).
Sep 99	System design defined for selected urban combat operation demonstration (TMR).
Oct 99	Demonstrate RST rolling chassis and vehicle subsystems.
Mar 00	Integrate and demonstrate advanced components into combat hybrid power system laboratory demonstration.
Jan 00	Complete preliminary Design Review of robotic perception, autonomous navigation, and locomotion technology brassboards and begin fabrication of same (TMR).
Jul 00	Complete critical Design Review of robotic perception, autonomous navigation, and locomotion technology brassboards and system conops (TMR).
Sep 00	Assemble subsystems and integrate into Marine Corps RST-V chassis.
Mar 01	Demonstrate 4-ton RST vehicle system capabilities in Advanced Warfighting Experiment (AWE).
Jul 01	System demonstration in urban mission scenario (TMR).

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

DATE February 1998

APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 3 Advanced Technology Development		R-1 ITEM NOMENCLATURE Land Warfare Technology, PE 0603764E							
COST *(In Thousands)*	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Small Unit Operations LNW-02	43,170	38,609	55,890	60,413	61,700	75,500	65,000	Continuing	Continuing

(U) **Mission Description:** The objective of this program is to develop critical technologies that will enable dispersed units to effectively perform warfighting operations traditionally accomplished with massed forces. With declining resources and a smaller military, the Services must be prepared to quickly project sufficient power to achieve United States objectives rapidly and effectively. Due to the reduced forward presence of US forces, future deployment of our forces will be restricted by airlift assets and in-theater infrastructure; and they will operate under more complex rules of engagement. Adversaries who are not very powerful may still possess sophisticated technology that will place our forces at risk. These risks are increased if our forces are massed to conduct traditional conventional operations. To fight effectively in the future, the Army and Marine Corps are developing concepts of operation (Army - Force XXI and Army After Next; and Marine Corps - Sea Dragon and Extending the Littoral Battlespace Advanced Concept Technology Demonstration) whose tactical implementation will vary, but whose similarities include lighter, more lethal, more flexible forces that are widely dispersed throughout the battlefield. The objective is to enable these forces to quickly control a large battlespace with dispersed forces, control the operational tempo, engage enemy targets with remote fire, and operate effectively across the spectrum of conflict and in a variety of environments.

(U) The keys to success for these units are a vastly improved and highly integrated comprehensive awareness system, robust communications, and an integrated, scaleable common grid of the battlespace. While there are many technology developments underway that will assist the Services to accomplish their objectives, at the tactical level there are technology gaps that DARPA will help narrow under the Small Unit Operations (SUO) program. Technology development efforts will focus on a comprehensive awareness capability that provides real-time, essential information for small units and individual warfighters; wireless communication technologies to permit exchange of voice, digital and video data with other systems; geolocation technologies that provide navigation information in built-up, forested and mountainous environments; internetted tactical surveillance and targeting sensors to complement information requirements not satisfied by national, theater, and component sensor programs; and automated tasking and control technologies for air and ground systems. As these technologies mature they will be tested and evaluated. Engineering demonstrations with combatant participation will be conducted to assess program progress in a realistic environment which provides critical user feedback. After successful tests and evaluation, or further refinement of the technologies, they will be integrated and tested with operational units.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 1998
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Land Warfare Technology, PE 0603764E, Project LNW-02

(U) **Program Accomplishments and Plans:**

(U) FY 1997 Accomplishments:

- Continued development of requisite technologies to provide precision geolocation. ($5.2M)
- Assessed advanced concepts and technologies for Small Unit Operations (SUO) applications. ($2.3M)
- Conducted field experiments to determine warfighter requirements and demonstrated SUO technologies at Warfighter exercises. ($2.4M)
- Initiated developments for situation awareness and real-time tasking and control technologies focusing on tactical picture generation, tactical forecast, and situation assessment functionality. ($6.4M)
- Initiated technology development for tactical communications capability. ($5.4M)
- Developed Situation Awareness System architecture and initial design concept. ($5.2M)
- Evaluated tagging, robotics and on-demand imagery concepts. ($5.2M)
- Developed internetted remote control sensors to detect, localize and characterize targets. ($4.7M)
- Demonstrated sniper and mine detection technologies. ($3.9M)
- Developed surveillance and targeting sensor systems for dispersed operations. ($2.5M)

(U) FY 1998 Program:

- Conduct field experiment of geolocation integrated brassboard system for restricted environment geolocation. ($3.1M)
- Conduct demonstration of unique time difference of arrival breadboard for 3 meter indoor geolocation accuracy. ($.3M)
- Assess advanced concepts and technologies for SUO applications. ($2.2M)
- Conduct field experiments and demonstrate SUO technologies at CINC and Warfighter exercises. ($5.0M)
- Continue development of situation awareness technologies focusing on plan generation and user interface functionality. ($1.5M)
- Continue development of tactical communications capability. ($3.5M)
- Develop and demonstrate Situation Awareness System detailed design. ($12.1M)
- Continue development of internetted remote control sensors to detect, localize and characterize targets. ($2.2M)
- Continue development of surveillance and targeting sensors systems for dispersed operations. ($8.7M)

(U) FY 1999 Program:

- Assess advanced concepts and technologies for SUO applications. ($3.2M)

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

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APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 3 Advanced Technology Development

R-1 ITEM NOMENCLATURE
Land Warfare Technology,
PE 0603764E, Project LNW-02

- Conduct field experiments and demonstrate SUO technologies at CINC and Warfighter exercises. ($5.6M)
- Complete developments for the situation awareness and real time tasking and control technologies. ($1.7M)
- Complete technology development for tactical communications capability. ($2.4M)
- Complete evaluation of enabling technologies associated with Situation Awareness System design. ($9.0M)
- Complete detailed design of Situation Awareness System and begin development of Situation Awareness brassboard system. ($19.1M)
- Continue development of internetted remote control sensors to detect, localize and characterize targets. ($5.2M)
- Continue development of surveillance and targeting sensors systems for dispersed operations. ($9.7M)

(U) **Program Change Summary:**   (In Millions)

	FY 1997	FY 1998	FY 1999
President's Budget	52.7	53.6	58.4
Appropriated	41.4	47.0	N/A
Current Budget	43.2	38.6	55.9

(U) **Change Summary Explanation:**

FY 1997   Increase reflects program repricing.
FY 1998-99 Decrease reflects transfer of Tasking & Control, Cooperative Mobile Sensors, and Robotics efforts to the Tactical Mobile Robotics Program to project LNW-01.

(U) **Other Program Funding Summary Cost:**   N/A

(U) **Schedule Profile:**

Plan   Milestones
Apr 98 Demonstrate brassboard lifeline communication technology.
May 98 Complete precision clock environmental and cell life testing.
Aug 98 Complete preliminary sensor delivery vehicle flight test.
Oct 98 Demonstrate and characterize various brassboard geolocation technologies.

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APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 3 Advanced Technology Development

R-1 ITEM NOMENCLATURE
Land Warfare Technology,
PE 0603764E, Project LNW-02

Jan 99 Conduct critical technology proof-of-concept demonstration of Situation Awareness System design.
Aug 99 Demonstrate sensors, tasking and control brassboard.
Nov 99 Demonstrate brassboard Situation Awareness System network design.
Jul 99 Brassboard testing and evaluation of internetted micro unattended ground sensor system.
Aug 99 Brassboard demontration of broadband targeting sight.

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APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 3 Advanced Technology Development

R-1 ITEM NOMENCLATURE
Joint Strike Fighter Program,
PE 0603800E, R-1 #56

COST (In Thousands)	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Joint Strike Fighter Program JA-01	70,261	23,019	0	0	0	0	0	0	N/A

(U) **Mission Description:** The Joint Strike Fighter (JSF) Program is the focal point for defining affordable next generation strike aircraft weapon systems for the USN, USMC, USAF, and allies. Program emphasis is on facilitating the evolution of fully validated and affordable joint operational requirements, and demonstrating cost leveraging technologies and concepts to lower risk prior to entering engineering and manufacturing development (E&MD) of the JSF in FY 2001. The JSF Program is a joint program with no executive Service. Since FY 1995, the Navy and Air Force have provided approximately equal shares of annual program funding. DARPA's Advanced Short Take Off Vertical Landing (ASTOVL)/Conventional Take Off and Landing (CTOL) Common Affordable Lightweight Fighter (CALF) project (previously known as ASTOVL) was integrated with the JSF program by FY 1995 legislation. DARPA contributed funding for the JSF Program in FY 1996 under this new program element. The US/UK international collaborative CALF Program conceived by DARPA was investigating a revolutionary approach for melding advanced technology, multi-service commonality, and improved business practices into the demonstration of an affordable, capable replacement for the F-16, F/A-18, and AV-8B. DARPA has brought this insight and experience to bear in integrating the structure and philosophy of the CALF program within the JSF framework. DARPA is now serving as the Director for Joint Advanced Strike Technologies within the JSF program organization. This ensures that DARPA's expertise in advanced weapon system technologies, streamlined acquisition, and rapid prototyping are brought to bear in the JSF technology demonstration program.

(U) **Program Accomplishments and Plans:**

(U) FY 1997 Accomplishments:

- Commenced ground demonstration of the concept demonstrator aircraft propulsion systems and technology maturation of the propulsion systems for the preferred weapon system concepts. ($33.0M)
- Commenced alternate engine design and development. ($15.0M)
- Conducted concept demonstration program wind tunnel and propulsion test facilities support. ($17.3M)
- Commenced technology maturation for prognostics and health management. ($4.2M)
- Conducted an avionics technology maturation project. ($.8M)

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 3 Advanced Technology Development		R-1 ITEM NOMENCLATURE Joint Strike Fighter Program, PE 0603800E, Project JA-01

(U) FY 1998 Program:
- Continue ground demonstration of the concept demonstrator aircraft propulsion systems and technology maturation of the propulsion systems for the preferred weapon system concepts. ($22.2M)
- Conduct Prognostics and Health Management (PHM) technology maturation for the Joint Strike Fighter (JSF) alternate engine. ($.8M)

(U) FY 1999 Program: N/A

(U) **Program Change Summary:** (In Millions)

	FY 1997	FY 1998	FY 1999
President's Budget	78.4	23.9	0
Appropriated	76.9	23.0	N/A
Current Budget	70.3	23.0	0

(U) **Change Summary Explanation:**

FY 1997 Decrease reflects $4.0 million reprogrammed to Arsenal Ship, PE 0603763E, Project MRN-01, and $2.6 million reprogrammed to the SBIR Program.

(U) **Other Program Funding Summary Cost:** (In Millions)

	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001
PE 0603800F	251.6	458.1	465.3	240.5	23.6
PE 0603800N	243.3	448.9	461.4	245.0	26.3
United Kingdom	71.0	55.0	34.0	26.0	0
Multilateral	8.3	9.6	7.6	5.0	1.7
(Norway, Denmark and Netherlands)					
Canada	0	4.3	3.0	2.7	0.6

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APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 3 Advanced Technology Development

R-1 ITEM NOMENCLATURE
Joint Strike Fighter Program,
PE 0603800E, Project JA-01

(U) **Related RDT&E:** PEs 0604800N & 0604800F: Milestone II for a joint follow-on engineering & manufacturing development (E&MD) program for the Joint Strike Fighter (JSF) is planned in FY 2001. The E&MD program will develop a tri-service family of aircraft from concepts proven under the JSF Program, incorporating affordable technologies transitioned from the JSF Program.

(U) **Schedule Profile:**

Plan   Milestones
Mar 98 Begin testing of X-32 and X-35 aircraft engines.
Mar 01 Complete Milestone II for JSF Engineering Manufacturing Development.

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APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 3 Advanced Technology Development

R-1 ITEM NOMENCLATURE
Dual Use Applications Program,
PE 0603805E, R-1 #57

COST (In Thousands)	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Dual Use Applications Program GC-01 / GC-02	123,168	120,395	0	0	0	0	0	0	N/A

* $50 million of the FY 1997 funding was originally appropriated as one year funding but subsequently extended as part of PL 105-56; as a result, these funds were budgeted in a separate project, GC-02, to improve accountability. FY 1998 funds were all budgeted in a single project, GC-01.

(U) **Mission Description:** The mission of the Dual Use Applications Program (DUAP) is to prototype and demonstrate new approaches for leveraging commercial research, technology, products, and processes for military benefit. These new approaches to working with industry, many of which were prototyped at DARPA, must become common throughout the DoD in order to take full advantage of the technological dynamism of the commercial sector. Specifically, DUAP encourages the Services to leverage commercial R&D to improve the cost and performance of military systems, and to insert commercial technology into fielded systems to reduce their operations and support (O&S) costs.

(U) The essence of dual use is to intentionally leverage commercial research, products, and processes for the benefit of the DoD. By its nature, this is an entrepreneurial activity that pushes the envelope of the rules, regulations, and procedures typical of traditional DoD acquisitions. While acquisition reform has helped clear the path, and experience has shown leveraging can work, it has also shown that leveraging is still unfamiliar and not widely adopted. The DUAP program's primary challenge is to demonstrate the benefits of commercial sector leverage to the Military Departments and make it a normal way of doing business throughout the entire acquisition spectrum.

(U) DUAP funds two initiatives to encourage commercial leveraging within the Military Services: the Dual Use Science and Technology (S&T) Initiative and the Commercial Operations and Support Savings Initiative (COSSI). The mission of the S&T Initiative is to encourage dual use—the joint development of dual use technologies with industry (i.e. projects that intentionally develop militarily useful, commercially viable technology). Under this initiative, each Service solicits, evaluates, prioritizes, and nominates dual use S&T projects for DUAP funds. Each project is 50% cost shared with industry, and 25% cost shared with the Service; DUAP provides the remaining 25%. All projects are managed by the Services and awarded using either Cooperative Agreements or Other Transactions. This is essentially a "learning by doing" approach to dual use S&T in the Services, with dual use funds being used as an incentive. COSSI's mission is prototype an approach the Services could adopt to routinely insert commercial technology into fielded systems to reduce their O&S costs. In Stage I of COSSI projects, DUAP and the selected firms share the cost of developing and delivering prototype "kits" for use in a fielded system. Each kit consists of a

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APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 3 Advanced Technology Development	Dual Use Applications Program, PE 0603805E, Projects GC-01/02

commercial technology that has been adapted and qualified for insertion. The firms work with their military customer to develop their technical approach and O&S savings analysis for the kits; proposals include a target price for purchasing the kits. It is anticipated that in Stage II, the military customer may purchase reasonable production quantities of the kits with Service funds. The acquisition goal is to purchase the kits and award, if applicable, fixed price maintenance contracts in Stage II, without recompetition, at a fair and reasonable price (i.e. the target price) based on the value of the kits, and without requiring proposers to provide detailed cost and pricing data.

(U) To reduce the administrative burden of government contracts and make COSSI more attractive to commercial firms, Stage I is conducted using "other transaction" prototyping agreements.

(U) In FY 1999 all Dual use Application Program funding has been budgeted in the Service appropriations with a small portion reserved at OSD as an incentive for joint programs. In the case of COSSI, each Service will solicit, evaluate, and select proposals for funding. Proposers will be required to provide at least 25 percent of the non-recurring engineering, test, and qualification costs associated with selected projects. Selected projects must also have the written support of a military customer able to purchase the kits after the engineering and testing is completed. The funding reserved by OSD will be used for COSSI projects that provide 50 percent of the funding with the remainder provided by the participating Services. The S&T program will also transfer to the Services for execution in FY 1999 and out.

(U) **Program Accomplishments and Plans:**

(U) FY 1997 Accomplishments:

- S&T Initiative: A total of 69 S&T projects were selected to receive DUAP funding; 38 from the Army, 14 from the Navy, and 17 from the Air Force. Dual use funds committed to these projects were matched by the Services and industry matches both the dual use and Service funds. Based on this formula a $67M dual use investment has resulted in a $275M investment in the development of dual use technologies. ($73.1M)
- COSSI: In May of 1997, 30 COSSI projects were selected for funding by DUAP; 10 for the Army, 14 for the Navy, and 6 for the Air Force. The net present value of the savings from these COSSI projects is initially estimated to be as high as $3 billion dollars. ($50.0M)

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APPROPRIATION/BUDGET ACTIVITY	DATE February 1998
RDT&E, Defensewide BA 3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Dual Use Applications Program, PE 0603805E, Projects GC-01/02

(U) FY 1998 Program:
- S&T Initiative: The FY 1998 initiative will be executed by the Services for new awards. ($72.1M)
- COSSI: Funding for COSSI is only being used to complete projects started in FY 1997 in keeping with Congressional direction. ($48.3M)

(U) FY 1999 Program Plans: N/A

(U) **Program Change Summary:** (In Millions)

	FY 1997	FY 1998	FY 1999
President's Budget	250.0	225.0	225.0
Appropriated	181.2	120.4	N/A
Current Budget	123.1	120.4	0

(U) **Change Summary Explanation:**

FY 1997 Decrease reflects rescission for the FY 1997 Supplemental Appropriations Act; reduction for OSD internal reprogramming for the National Center for Manufacturing Sciences; reprogramming of Small Business Innovation Research funding to PE 0605502E; and minor program repricing.

FY 1999 Funding transferred to the Services for execution.

(U) **Other Program Funding Summary Cost:** N/A

(U) **Schedule Profile:** N/A

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APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 6 RDT&E Management Support

R-1 ITEM NOMENCLATURE
Management Headquarters (R&D),
PE 0605898E, R-1 #120

COST (In Thousands)	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Management Headquarters MH-01	35,340	35,039*	38,611	42,603	43,782	45,310	46,602	Continuing	Continuing

* It is anticipated that further below threshold reprograming into Management Headquarters accounts will be required to meet statutory payroll and negotiated infrastructure costs.

(U) **Mission Description:** This program element is budgeted in the Management Support Budget Activity because it provides funding for the administrative support costs of the Defense Advanced Research Projects Agency. The funds provide personnel compensation for civilians as well as costs for building rent, physical and information security, travel, supplies and equipment, communications, printing and reproduction. In addition, funds are included for reimbursing the Military Services for administrative support costs associated with contracts undertaken on the Agency's behalf.

(U) **Program Accomplishments and Plans:**

(U) FY 1997 Accomplishments:
- Funding under this program element in FY 1997 supported management and administration for the RDT&E programs assigned to DARPA. The majority of the funds were required for the pay of personnel who operate the Agency. The funding level reflects the rental costs associated with the expansion of office space, and the related support and security requirements.

(U) FY 1998 Program:
- DARPA will continue to fund management and administrative support costs. The growth in Management Headquarters is due to increased salary requirements to accomodate mandated pay raises and a change in the mix between civilian and Intergovernmental Personnel Act appointments. This effort, which includes technical and academic personnel from commercial sector, has full support from the Department as evidenced by DoD legislative proposal to expand Intergovernmental Personnel Act appointments and increase funding in this program element. In addition, building rents and utilities have increased due to renegotiation of leases.

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APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 6 RDT&E Management Support	Management Headquarters (R&D), PE 0605898E, Project MH-01

(U) **FY 1999 Program:**
- DARPA will continue to fund management and administrative support costs. Increased costs reflect the increased salary requirement associated with hiring additional Intergovernmental Personnel Act employees and the cost of a mandated pay raise.

(U) **Program Change Summary:** *(In Millions)*

	FY 1997	FY 1998	FY 1999
President's Budget	36.4	39.2	41.3
Appropriated	33.8	34.8	N/A
Current Budget	35.3	35.0	38.6

(U) **Change Summary Explanation:**

FY 1997 Increase reflects reprogramming necessary to support current staffing levels, statutory pay increases, fixed building rents, and enhanced security requirements.

FY 1998 Increase reflects initial below threshold reprogramming adjustments to meet infrastructure contract requirements. Further reprogramming will be necessary to fully fund statutory pay raises and other infrastructure costs.

FY 1999 Decrease reflects deferred implementation of the Industrial IPA program (legislation was not approved in the FY 1998 Authorization Act), and acceleration in DARPA's end-strength drawdown in keeping with Departmental direction, and other repricing.

(U) **Other Program Funding Summary Cost:** N/A

(U) **Schedule Profile:** N/A